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The Practical Teacher

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The Practical Teacher

A MONTHLY EDUCATIONAL JOURNAL.

Edited by JOSEPH HUGHES.

'Knowledge is proud that he has learned so much,
Wisdom is humble that he knows no more.'—COWPER.

VOL. XVI. No. 5. NOVEMBER, 1895. PRICE, 6D. POST FREE, 8D.

KINDERGARTEN DRAWING FOR THE LOWER STANDARDS.

(*See this month's Supplement.*)

THE drawing of CAPITAL LETTERS is by no means so difficult as may be supposed. Capitals will therefore prove most interesting exercises for children in Standards I., II., and III. The alphabet here given is made as simple in form as possible, and each letter has been drawn on squared paper in order that the proportions of each may be easily seen. It is possible to obtain good drawings of every letter from the most apt pupils of Standard II., and many of them may be drawn nicely by children of Standard I.

When drawn and coloured they may be used to form words. When used for this purpose the papers on which they have been drawn must be carefully cut down to 6 inches high, and a width equal to 2 inches more than that of each letter. The letters must then be placed side by side to form the required word or words. I have seen the names of schools formed in this way, and hung against the walls with very good effect. Mottoes and proverbs may be similarly dealt with. Let all the letters in a word be of the same colour. Initial letters may be drawn half as large again, and be of a colour different to that used for the rest of a word.

Directions for Drawing the Letters (Side of each square represents one inch).—All the letters are 5 inches high. All lines in a letter must be thinly drawn and afterwards thickened where required. The width between each pair of lines is everywhere 1 inch, except in parts of B and R and all W. That is, if a straight line be drawn across any bar, and at *right angles* to it, the width from line to line will be 1 inch.

A, M, V.—The letters A, M, V are each 5 inches square. Draw the square for each. In A draw lines 1, 2, and 3, and at each end of the lines 1 and 2 draw lines 1 inch long, and at right angles to 1 and 2, as shown. The remaining lines need no explanation. V is practically A turned about. For M draw lines 1 to 7, and at both ends of 6 and 7 perpendiculars 1 inch long. The rest of the letter is easy. Instead of drawing 6 and 7 to the top corners of the square, they may be drawn to the points $\frac{1}{4}$ inch from the corners.

B.—For B draw a rectangle $5 \times 4\frac{1}{2}$, with horizontal lines across at every inch. Next draw line 1. The upper large curve is about $\frac{1}{4}$ inch away from the right side of the rectangle, and the lower large curve slightly nearer. At *d* the distance between large and small curves is 1 inch, at *n* it is slightly less.

P and R are 4 inches wide. The remarks *d* and *n* above also apply in drawing R. P needs no description. For R draw a P and a curve to *n*. Next draw the line *s* slightly curved at top. At the lower end of *s* draw a perpendicular (1 inch), and the line *f* will complete the R.

C, G, O, Q are each $4\frac{1}{2}$ inches wide. The various straight lines shown must all be drawn, and will make the drawing of the curves comparatively easy. There is an *o* in each of these letters, and only in Q is there any great difficulty. The point 1 is 2 inches up the middle line. Point 2 is three quarters of an inch from *c*. Lines 3 and 4 are 1 inch perpendiculars to the line 1–2.

D, E, F, H, I, L, S, T, and U should require no explanation. S is very difficult for young pupils, but can be done by *some* second standard children.

J is only $3\frac{1}{2}$ inches wide. Find a point *p* 2 inches up the line *ab*. Join *p* to *t* $1\frac{1}{2}$ inches from *u*; *tv* is 1 inch long.

K.—For K draw the vertical and horizontal lines, and line 1. 2 and 3, 1 inch perpendiculars to 1, give the ends of 4. *tp* is $1\frac{1}{4}$ inches. Draw *pq*. At *p* and *q* erect 1 inch perpendiculars to *pq*, giving the ends of 6.

In N, X, and Z, the angle at which the 1 inch lines marked 1 are inclined may be obtained by guesswork, or the lines marked 2 may be made $1\frac{1}{4}$ inches long.

W is 6 inches wide. Each small line is 1 inch long. *d* is $1\frac{1}{4}$ inches. The perpendicular distance between the pairs of parallel lines is in this letter

slightly less than one inch. The space occupied by the letter would be too crowded if this deviation from the general rule were not adopted.

Y.—The lines marked 1 are $4\frac{1}{2}$ inches long, and form an equilateral triangle with *ab*. The lines marked 2 are each 1 inch.

It will be noticed that several of the letters are raised or blocked. The method of doing this is very simple. On the right and under sides of every thickness draw lines at 45° inclination, and one inch long. Any number of lines may be drawn, but only a small number—those from the corners—will be strictly necessary. Join the ends of these lines and the drawing is complete. When colouring, let this part be done with a darker colour than the body of the letter.

This kind of work may be varied considerably—(*a*) to the right and downwards; (*b*) to the left and downwards; (*c*) to the right and upwards; (*d*) to the left and upwards; and the lines may be inclined at 30° or 60°.

The various stages for (*a*) are shown in the diagrams.

It must not be supposed that this one set of letters would be accepted as a 'varied occupation,' as with an expert teacher they could be all taught (to a Third Standard) in four lessons.

Another and slightly more difficult set will appear in a future number of this Journal.

NOTE.—See new Rules for Drawing in Elementary Schools, Appendix, Stage 2.

APPENDIX.

SCHEME OF INSTRUCTION IN DRAWING FOR SMALL SCHOOLS.

The following scheme is intended for the older scholars in SMALL SCHOOLS in which the average attendance, exclusive of infants, does not exceed 60, but it may, with the consent of the Inspector, be used in schools of a somewhat larger average attendance, if the Managers can show that educational benefit will result from its use.

The scholars may be sub-divided into two Groups, and the scholars in the lower Group may continue two or three years in the lower Stage at the discretion of the Managers, and may be sub-divided into such classes as may be required. Reasonable portions of the higher Stage may be taken by each scholar in successive years, and the scholars formed into one Group, or into Classes taking different portions.

—	1ST STAGE.	2ND STAGE.
DRAWING, FREEHAND* - -	I. Freehand Drawing of lines in various positions; parallel lines, angles, triangles of different forms, squares, and oblongs; combinations of such lines and figures; diagonals of squares, and oblongs; lozenge forms and squares and oblongs with their diagonals in a vertical position. Combinations of lines to form zigzags and simple frets; curved lines, combinations of curved lines with triangles, squares and oblongs to form simple patterns.	I. Freehand Drawing from simple outlines of ornament, drawing from easy flat examples of foliage and flowers, *also of capital letters.* Drawing from common objects‡ of simple form. Combinations to form simple patterns.
DRAWING WITH INSTRUMENTS.	II. Drawing with the ruler all the above-mentioned lines and figures; also enlargements of given figures in a definite ratio, but not to scale. Application of curved forms, drawn freehand, to figures drawn with instruments.	II. Drawing with rulers geometrical figures such as triangles and polygons not at first demanding complete accuracy, but subsequently to be drawn to scale. The use of the 2-foot rule to be practised. Making of scales on stiff paper, not involving more difficult divisions than $\frac{1}{4}$-inch to the foot, such scales to be subsequently used for all measurements for drawings. Drawing to scale, from flat examples, on plain paper and on squared paper. *Drawing to scale simple objects and large block letters.*
	This stage is intended to correspond to that part of the Illustrated Drawing Syllabus† of the Department which includes the instruction given in Standards I. to III.	This stage is intended to correspond to that part of the Illustrated Syllabus† which includes the instruction given in Standard IV. and upwards.§

* The beginners in the lowest class may use slates both for freehand drawing and for ruler work. Full definitions must accompany the work in each stage.

† It is intended that the instruction given under this scheme, in both stages, should be in general accordance with the 'Illustrated Syllabus of the Course of Instruction in Drawing' of the Department of Science and Art.

‡ All common objects should be of a size large enough to be seen by all the scholars, and in drawing from flat examples large diagrams should be used as far as possible.

§ If additional time can be devoted to drawing after a fourth year, it would be expedient to take up geometry, including such problems as the division of a given line into a given number of equal parts by trial and by construction; the drawing of lines parallel and perpendicular to given lines by means of set squares, and also by construction; the construction of an equilateral triangle or a square of a given side; the construction of an angle equal to a given angle; the bisection of a given angle, etc.,

or

Simple plan and elevation of regular solids, together with isometrical projections suitable for manual instruction.

A 1781 ESSAY ON EDUCATION.

BY THOMAS CARTWRIGHT, B.A., B.SC. (LOND.),

Author of 'Mental Science and Logic for Teachers.' Late Director of the Birkbeck Training Classes and Lecturer therein on School Method.

ESSAYS on education are not popular. Quick proved this to his cost when issuing his now-famous Essay on Educational Reformers. They never were popular, and in all human probability they never will be popular. Hence the writer on this subject expects little in the way of recognition, and less in the way of reward. That this should be the case is only one of the many proofs of the lack of real sagacity on the part of the cute century-end reader, to whom everything is of more importance than the proper bringing up of the young. Something like this must have been in the mind of Henry Home, Lord Kaimes, when, in 1781, he indited to the Queen the 'Loose Hints upon Education,' which the reader of the 'PRACTICAL TEACHER' is to-day invited to examine. Hence my Lord's not altogether artless dedicatory address to Her Majesty, in which we read the following: 'I have little doubt of convincing those who are disposed to give attention that dry subjects seem at present not to be in request. One sure way there is to procure attention, and I know no other. If Your

Majesty will graciously condescend to patronise this little work it will become fashionable: every one will read; a number will approve; and perhaps a few will seriously think of a reformation.' Whether the sanguine expectations of Lord Kaimes ever received that realisation which such dulcet utterances would seem to merit, history sayeth not. Judging from the experience of his predecessors and successors in this particular field of literary enterprise, the answer would be a decided negative. Be that as it may, the fame of Henry, Lord Kaimes, has not been permitted altogether to die out, thanks to the efforts of the South Kensington Educational Library, in which Valhalla of educational essays that of Lord Kaimes has its abiding place.

The amiability of the author peeps out from every page of his book. Indeed, so much is this the case as to render it impossible to resist the belief that Lord Kaimes was one of those ardent lovers of children to whom right upbringing is a sacred duty of first importance.

The book divides itself into ten sections and two appendices.

That there is nothing new under the sun is a saying which, its triteness notwithstanding, is, sooth to say, becoming somewhat wearisome; yet one would scarcely expect to find in the pages of Lord Kaimes a strong recommendation in favour of that citizen-instruction which is even now as uncommon as it is desirable. Such, however, is the case, as will appear from below: 'Why not schools for teaching the science of politics, erected at the expense of the public, as schools are for teaching the art of war? Such an institution, inconsistent indeed with absolute monarchy, would suit admirably the constitution of Britain. Sure I am that never in this island was there more occasion for such schools than in the present time.'

What can be more forcible than the following appeal in favour of proper education: 'Parents, your children are not your property. They are entrusted to you by Providence to be trained up in the principles of religion and virtue; and you are bound to fulfil the sacred trust. You owe to your Maker obedience; you owe to your children the making of them virtuous; you owe to your country good citizens; and you owe to yourselves affectionate children!'

It may be asked upon what authority this noble Lord presumes to pose as an educational Solon. The reply is ready to hand. Great love for children, coupled with a mind intent upon the philosophy of education (he had read his Emile, and was also familiar with Fénélon's 'Instructions for Educating a Daughter'), inclined him to the study of this question of questions, which so few have sufficient hardihood to face.

His estimate of Rousseau is, it is curious to remark, exactly in agreement with the verdict of more modern times. 'Rousseau,' says he, 'has, unhappily, too much imagination to be confined within so narrow bounds; he builds castles in the air, and in vain endeavours to give them foundation. His 'Emile,' however, with all its imperfections, is a work of great genius; and he has given many hints that deserve to be prosecuted.'

In the first section of this truly interesting book the authority of parents is dealt with, and the sound doctrine is laid down that the child must be restrained in its own interests, and that for the same reason punishment must be resorted to. In this connection he quotes, only, of course, to condemn, the contrary doctrine of Rousseau, and in support of his views he quotes an experience which is certainly worthy of reproduction, if only as an experiment in applied education. 'I am acquainted with a very respectable couple, disciples of Rousseau. They seldom, hitherto, have employed any means for keeping their children in order but promises and entreaties. As the father was playing at chess with a friend, one of his children, a boy of four years, took a piece from the board and began to play with it. "Harry," says the father, "let us have back the man, and there's an apple for you." The apple was soon devoured, and another chessman laid hold of. In short, they were obliged to suspend the game until the boy, turning hungry, was led away to supper.' A better illustration of the utter insufficiency of moral suasion as a disciplinarian could not be well imagined.

Here is another story from which may be learnt the inherent weakness of trusting to the consequences of actions as correctives. 'A gentleman, upon a visit at a friend's house, heard little master crying below stairs. The mother, alarmed, was told that he wanted to ride up to table upon the roast beef, and that the cook did not relish the project. The mother was for letting Dickie have his will. But the father luckily replied, that the sirloin would probably be too hot a seat for Dickie.' It is only fair to say that Lord Kaimes gives credit to Rousseau in that he would have reformed his doctrine to 'giving children full liberty in matters indifferent, such as can neither hurt themselves nor others.'

Like Pestalozzi, Lord Kaimes takes the child from early infancy; indeed he even goes so far as to say that cheerfulness on the part of the mother prior to the child's birth will have a due influence upon the child yet unborn, the commencement of whose education is thus pre-natal. Without following out this curious line of thought, it will be sufficient to say, that the whole atmosphere of this second section, dealing with the first stage of life, is of the happiest and cheeriest description. Even Sir John Lubbock, who is ceaseless in his efforts to inculcate in men's minds a belief in the duty of being happy, would be delighted with the views of Lord Kaimes, who would make the age of childhood, so far as such a thing lies within the bounds of possibility, a period of unalloyed bliss; not merely because of the pleasure experienced at that period, but because of the value of a pleasant memory and of a disposition predisposing its owner to look ever on the bright side of things. To keep this ever in view as a rule of conduct might not bring the modern teacher much in the way of *kudos*; it would, however, be eminently praiseworthy and intelligent. As to the truth of the following contention of Lord Kaimes, there can be but one opinion. 'Almost every object that attracts our notice has its bright and its dark side; he that habituates himself to look at the dark side, will sour his disposition, and consequently impair his happiness; while he who constantly beholds the bright side, insensibly ameliorates his temper, and in consequence of it, improves his own happiness, and the happiness of all about him. *The gods invented industry to make us virtuous.*'

This song of the Greek poet Hesiod, with which

corresponds our 'Satan finds some evil still for idle hands to do,' constitutes an admirable commencement and a no less excellent summary of the third section on the management of children in their second stage. 'Nothing indeed equals industry for preventing vice. Parents and tutors, apply this observation to the children under your care. Keep them employed, keep them busy, and they will never have a wrong thought.' What teacher of experience is there who will not cordially endorse every word of this contention, and who amongst us again will refuse assent to the sagacious statement which comes close upon its heels? 'Train them to do everything for themselves as much as possible, which will not only promote their activity, but excite their invention.' Further on, in the same section, is encountered a nature lesson, which should be given in every school. 'To initiate children in the knowledge of trees, of fruit, and of their names, take a leaf from each of the common trees, an oak, a beech, an elm, etc. Spread them on a table, and point out to your pupils the particulars that difference each of them from the rest; and from time to time leaves of trees being common, your pupils will learn to know every tree at first sight by its leaf.' This same practice of realism is so consistently followed by our author, as to convince us that he is a veritable disciple of Comenius himself, all subjects being dealt with by him in the same fashion.

The anecdote which we are about to give will recall a similar action, to which much public attention has been drawn thereby, affording another instance of the difficulty of attaining to newness.

'The Earl of Elgin permitted his two sons in their hours of play to associate with boys in the neighbourhood, which he thought better than to expose them to be corrupted at home by his servants filling them with notions of their rank and quality. One day the two boys being called to dinner, a young lad, their companion, said, "I'll wait till you return, as there is no dinner for me at home." "Have you no money to buy it?" "No." "Come, then, and dine with us." "No." "Papa," says the eldest, "What was the price of the silver buckles you gave me?" "Five shillings." "Let me have them, and I'll give you the buckles." It was done accordingly. The earl inquiring privately, found that the money was given to the lad. The buckles were returned, and the boy was highly commended for being kind to his companions.' Such conduct as this Lord Kaimes would not leave to be called forth by mere chance. He would in every way strive to train children in benevolence, observing that 'The practice of doing good cannot fail to improve a benevolent disposition. Occupy your pupil in relieving the indigent, not only by his purse, *but by kindly office*. Convince him that he cannot be more honourably employed.'

Not only does our friend know his Rousseau; he is equally well acquainted with Locke, whose testimony he quotes in support of the great necessity for making full use of curiosity in education. 'Knowledge,' says Locke, 'is grateful to the understanding as light is to the eyes. Children are delighted when their inquiries are regarded, and their desire of knowledge encouraged and commended.'

From what has preceded it will readily be gathered that the child is not to be pampered. Self-restraint is to be imposed upon him from the first, and decision of character accompanied by wisdom are not to be absent from the list of virtues to be striven after.

It is highly improbable that a very effusive welcome will greet the following dictum. That does not affect its wisdom in the least. 'As soon as children are susceptible of verbal instruction, let them know that the chief use of clothes is to keep them warm; and that to be distinguished by their finery, will make them rather to be envied or ridiculed.'

The sixth section is a kind of *olla podrida* containing much sagacious reflection. The vexed question of rewards and punishments receives early and worthy notice, as will be seen from the following:—

'There is no branch of discipline that ought to be exercised with more caution than the distribution of rewards and punishments. If money, a fine coat, or what pleases the palate, be the reward promised, is it not the ready way to foment avarice, vanity, or luxury? Praise is an efficacious reward of which even children are fond; and when properly applied, it never fails to produce good behaviour. Punishment requires still more caution; as it ought to be made proportioned to the temper of the pupil as well as to the nature of the fault. I cannot recollect a fault that requires corporal punishment but obstinacy, which is inherent in some persons. Lying, I think, may be corrected, or rather prevented, by proper management. . . . To keep children in awe by the fear of corporal punishment will put them upon hiding their faults instead of correcting them.'

Section VI. has some very pertinent remarks concerning the 'Peculiarities respecting the Education of Females,' whilst in Section VII. the question of the day, viz., religious instruction is taken in hand. As Lord Kaimes did not live in the day of compromises and Rileys, he does not give us much guidance as to how the shoals and quicksands may be avoided. Nor need we concern ourselves with the next (Section VIII.), which deals with Instructions preparatory to the Married State.

The sub-title of the book informs us that it is 'Chiefly Concerning the Culture of the Heart,' and that we may be in no doubt as to what this really means we are supplied with an explanation as follows: 'The head is the seat of thinking, deliberating, reasoning, willing, and of all other internal actions. The heart is the seat of emotions and passions; and of moral perceptions, such as right and wrong, good and bad, praise and blame.'

Following out this distinction, the first eight sections have dealt with what may roughly be termed moral education, and it is no small part of the praise that must be vouchsafed to Lord Kaimes that he has deemed the moral side of education worthy of such a prominent position in his essay, and of such fulness in his treatment.

In dealing with intellectual education common sense again prevails, and realism is again recommended, preceded by every legitimate attempt to evoke a love for learning. He quotes Quintilian against the practice of forcing an uncongenial study upon a child as being likely to cause intellectual *nausea*, and says a good word for botany as an observative training subject.

Those of our friends on either side of the border

who believe in the teaching of dancing, may like to know that Lord Kaimes regarded this exercise with great favour. 'To be a good player on the harpsichord requires only a fine ear with perseverance; it is no index of mental faculty. To dance well, that is, to dance with pace and expression, a certain dignity of mind is requisite, supported by good sense; and therefore dancing well is an index of the mind.' After this, Paderewski must hide his diminished head in yielding the palm to Loie Fuller.

Concerning rule-teaching no modern could speak more emphatically than does our essayist. 'In teaching a language, it is the universal practice to begin with Grammar and to do everything by rule. I affirm this to be a most preposterous method, Grammar is contrived for men and not for children. Its natural place is between language and logic; it ought to close lectures on the former, and to be the first lectures on the latter. It is a gross deception that a language cannot be taught without rules. A boy who is flogged into Grammar rules, makes a shift to apply them; but he applies them by rote like a parrot. Boys find the knowledge they acquire of a language are not indebted to any rules, but to practice and observation. This is excellent—worthy indeed of Herbert Spencer.

Then follow several articles, one of which is upon the association of ideas, from which we learn that our author is an ardent disciple of Locke, whose works he appears to have studied with enthusiastic appreciation, especially that part which deals with the interesting subject of the association of ideas.

An appendix follows, which shows the worthy essayist in a less favourable light. In consists of extracts to be committed to memory by the pupil, thus showing that his pedagogic studies had not emancipated him entirely from the grand heresy of the Middle Ages, viz., that memory is mind, instead of being but a very small and comparatively unimportant part of that entity.

But we must not become hypercritical in dealing with an educationist of the seventeen hundreds. Rather must we exhibit a becoming admiration of the man who, in his love and sympathy for children, in his desire no less for their weal than for the good of the state, was not content to get hold of a few antiquated rules of thumb and swallow them wholesale, but who, on the contrary showed sufficient industry and zeal to acquaint himself with at least three important works of enlightened thinkers, and who furthermore, in true scientific spirit, set to work to test the opinions of these men in the only possible way, viz., by independent personal observation and experiment.

Such a man deserves better at our hands than hypercritical examination. We therefore take leave of them, with fervent thanks, for a pleasant and a profitable afternoon's study.

ELEMENTARY LESSONS IN AGRICULTURAL ZOOLOGY.

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CHAPTER IX.—INSECTS (*continued*)—LADY-BIRDS.

After considering the habits of so many forms of very destructive insects it is pleasant to be able to turn to another group of beetles, which are especially noteworthy for the beneficial influence they exert. These are the *Lady-birds*, so familiar to us in some years with their bright red wing covers and somewhat unpleasant habit of settling upon us when on our country walks. They are the representatives of a family called *Coccinellidæ*, whose general characteristics are the following:—They are almost hemispherical in shape, the under side being flattened; they have a small head which can be drawn in under the thorax to a certain extent; the head bears two antennæ which are thickened at their tips and which are composed of eleven joints; their legs are very short, so that they seem to touch the ground with their bodies; their feet are four-jointed. The colour of their wing cases varies in different species, but is usually variegated. Some are red with black spots, others reverse this order and have red spots on a black ground. They have an unpleasant way of discharging a very disagreeable fluid from their abdomen when they are handled, giving rise to a somewhat offensive odour.

They have a complete metamorphosis, passing through the three stages of larva, pupa, and imago. The larvæ are a good deal like those of the last group, the leaf-beetles, but are rather more slender and have longer legs, which stick out laterally. They are rather longer than the adult lady-bird. Their surface is somewhat spiny or covered with little excrescences sometimes called warts. The pupæ are blunt, somewhat angular chrisalides, variegated in colour after the fashion of the perfect insect. When they take the pupa form, they generally hang on the leaves. The perfect insect lays a large number of yellow eggs which are usually deposited in little heaps.

The advantages which they bring in their train are due to the fact that they prey upon one of the most destructive forms of insect that infest our fields, *viz.*, the *aphis*. These belong to an altogether different family, and will be separately discussed in a subsequent chapter. They form a succulent food of which the lady-bird is extremely fond. Both in the larval and adult forms they are endowed with an extraordinary voracity, and they multiply very curiously in proportion to the number of aphides which are found. The pest and the remedy for it thus seem to be developed together. Indeed, the lady-bird usually gets much the best of the competition between them, and after a year when the aphides are found in very great abundance, the next year will be characterised by an almost complete absence of them, on account of the destruction which the lady-birds work among their host.

The extreme abundance in which lady-birds follow the aphides, would scarcely be credited by anyone who has not actually seen them in such a season. Some observers have put on record the most extraordinary accounts of their numbers. Houses are spoken of as being rendered uninhabitable on account of the stench arising from the thousands and thousands that have invaded every room in them; of huge numbers washed up by the tide; of aphis-infected fields so studded with them, that the whole colour of the field appeared to be scarlet.

Some years stand out conspicuously in the past as showing the devastations of the aphides. In 1825 they ruined nearly the whole of the hop crop, scarcely a hop garden escaping. The lady-birds attacked the enormous horde with the result that in 1826 the hop crop was worth twenty times as much as in the preceding year.

The little heaps of yellow eggs are generally laid upon infested sprigs or leaves of the plants attacked by the aphis, so that when the larvæ are hatched they find themselves in the midst of their victims. Their extreme voracity thus has full play at once. The habits of the two insects are very interesting from this point of view. The aphis is a very slow moving insect, and does not seem to realise the danger in which it stands. It will even walk over the body of the lady-bird larva without appearing at all distracted by its presence, concentrating its thoughts upon its own depredations. The lady-bird larva is itself very sluggish, and its movements, when it makes any, are consequently extremely slow. It has a pair of very formidable jaws which soon make short work of the delicate body of the aphis. The result is that the larva can generally satisfy its appetite without moving at all from where it is resting, and it always finds itself surrounded by its prey.

The rate of destruction of the aphides can be gathered from the fact that a larva will destroy a full grown aphis in little more than a minute, indeed in some cases faster than this, a single grub having been known to devour no less than a hundred aphides in an hour. This is, however, beyond the usual rule; it would be better to compute that something like half this number per hour would be the ordinary rate of destruction.

The grub feeds upon the softer parts of the aphis, especially devouring the contents of the abdomen; the harder parts are usually rejected, and so a good deal of debris remains to show where the struggle has been going on. The destruction thus not only affects the individual aphis, but of course also prevents its producing any young ones to carry on its depredations.

The grub lives for about two or three weeks before assuming the

pupa form ; its life in the pupa condition covers about the same time, so that very soon the adult lady-bird is able to resume the work of aphis-destruction, which it does with an avidity about equal to that of the larva.

There are several species of lady-bird known in this country, some of which are very varied in their appearance. The most curious is *Coccinella variabilis*, whose colour may be black, yellow, or red. The elytra are covered with spots which vary in number, shape, position, and size. The black ones have usually red spots, the yellow and red ones having black spots, but there is a good deal of variety even in the distribution of colour. The distinguishing mark of this species is a raised semi-circular line near the apex of the wing cases, which is very noticeable, and which is not possessed by any of its allies.

A commoner form in this country is the Two-spot lady-bird, *Coccinella bipunctata*, which generally has a single black spot in the centre of each of its wing cases, which may be red or yellow. This species is also variable in its markings, for there are many black ones, with from two to six red spots upon the elytra. Again, the size of the single spot on each wing may vary, being sometimes round and sometimes square. Some have been found with a square outline in the middle of the wing, and inside this square a red blotch of uneven shape.

A somewhat rarer form is the *seven spot* (*Coccinella septem-punctata*), which carries seven black spots in a red ground. This species does not vary much, as the other two do, the markings being generally very constant. This species usually appears very early in the year.

The unpleasant odour which has been alluded to is due to a somewhat oily fluid which the insect can eject at will. It comes from the abdomen according to some observers, but according to others it is ejected from the joints of the limbs which spring from the thorax. It is a very difficult fluid to remove when once it has been shed, which is probably due to its greasy character.

We are now in a position to put together and recapitulate briefly what has been the substance of the last three articles, in which we have discussed the chief forms of beetles which are of agricultural importance.

1. The beetles are all furnished with formidable mouth-parts adapted for biting. They have four wings, of which the two front ones form the elytra or wing-cases, and are generally very characteristically marked with colours, variably disposed. These cases protect the delicate hind wings while the insect is at rest. The metamorphosis is complete ; the larvæ are either maggots or grubs. They, as well as the adult insect, are very voracious.

2. The chafers are a very injurious family, whose larva commits its depredations chiefly underground, attacking roots of grasses and vegetables. They also attack the hearts of flowers.

3. The wireworm, another subterranean pest, is the larva of the skip-jack beetle. It does great injury to the roots of grasses and other pasturage, and also attacks fleshy underground structures, such as potatoes and turnips. The life of the larva extends over three years or more, it being preserved during winter by burrowing into the soil, and there hibernating. The pupa stage is passed in the soil, where the grubs prepare for themselves little cells of earth in which to effect the metamorphosis. In this habit they behave like the chafers.

4. The family of weevils assails chiefly the fruit and seeds of various plants, especially those belonging to the leguminosæ and the cereal grasses. The female lays her eggs in the seeds, which thus afford food to the larva at once on its being hatched. Seeds attacked in this way are completely eaten up by the insects, only a shell or husk remaining.

Some species attack also the leaves and young shoots, eating them from the edges inwards and destroying all the soft part which discharges the function of the leaves, so causing the plant to perish from inanition.

5. The weevils are easily recognised from the peculiar proboscis which they have, and from the fact that the hinder part of the abdomen is not protected by the wing cases.

The great damage they bring about is largely attributable to the numbers in which they are produced, and not to the amount caused by the individual weevil.

6. The weevils multiply with very great rapidity, two or sometimes three broods appearing in the course of the summer and autumn. The last brood generally lives throughout the winter, hibernating in haystack-refuse, etc.

7. The weevils may be classified into the *Mouse-tooth* weevils and the *Gall* weevils, of each of which there are several species.

8. The next group of injurious beetles are the so-called *Leaf Beetles*, of which the famous Potato bug or Colorado beetle is the most formidable. They are characterised by coloured markings upon the wing-cases, which are arranged differently in different species.

9. A potato field attacked by this pest is very soon stripped of foliage, and this at so early a period in the development of the plants that the formation of the tubers is altogether prevented. When the young plants come up the beetles that have survived the winter come out of their hibernating quarters and devour the young leaves from the edges inwards.

10. The leaf-beetles multiply with as great rapidity as the weevils. The eggs are laid upon the leaves, each female producing something like a thousand. They hatch in about a week, and the larvæ feed with enormous voracity for about three weeks, when they fall to the ground and assume the pupa stage. At least three broods are produced every year.

11. Another beetle of this family attacks especially the asparagus plant. Its larvæ have the peculiar property of ejecting from their mouths when disturbed a drop of very offensively-smelling liquid. They multiply even faster than the potato beetle.

12. Other families of leaf-beetles attack cultivated cruciferous plants, and so damage market gardens very extensively. Among these the *Turnip Flea* is very conspicuous.

13. The last group calling for attention is that of the lady-birds, which do good service to the farmer by preying upon the aphides or green lice which are so destructive to leaves.

(*To be continued.*)

NEW COMPOSITION STORIES.—STANDARD V.

Suitable for 'Unseen Tests' in Reading also.

415.

THE TRAVELLER'S TREE.—A European traveller on his way from the coast of Madagascar to the capital had emptied his water flask and was suffering from thirst. He asked one of the natives of his party when he should be able to obtain water. 'Any time you like, sir,' said the native, with a smile. The European saw no sign of springs or water ; but the natives conducted him to a group of palm-like trees standing in a cluster on the edge of the forest, with straight trunks and big bright-green leaves growing from the opposite sides of the stalk, and making the tree appear like a great fan. The white man gazed admiringly at the tree. 'You think it a fine tree, but I will show you what it is good for,' said the native. He pierced the root of one of the leaf-stems at the point where it joined the tree, whereupon a stream of clear water spurted out, which the European caught in his water-can, and found to be fresh, cool, and excellent to drink. After the party had satisfied their thirst and taken a supply, the native who had spoken went on : 'This tree, which is good for us in more ways than one, we call the traveller's tree. The leaves drink in the rain that falls on them, and when it has passed through them it becomes very pure and sweet.'

416.

BRUCE AND THE SPIDER.—King Robert Bruce laid down one night in a barn belonging to a loyal cottager. In the morning, still reclining his head on the pillow of straw, he beheld a spider climbing up the beam to the roof. The insect fell to the ground, but immediately made a second attempt to ascend. The movement attracted the notice of the King, who, with regret, saw the spider fall a second time from the eminence. It made a third unsuccessful attempt. Not without concern and curiosity, the monarch twelve times beheld the insect baffled in his design ; but its thirteenth attempt was crowned with success ; it gained the summit of the barn ; when the King, starting up, exclaimed, 'This despicable insect has taught me perseverance. I will follow its example. Have I not been twelve times defeated by the enemy's superior force ? On one fight more hangs the independence of my country.' In a few days his anticipations were fully realized by the victory of Bannockburn.

417.

THEIR LAST DUEL.—A good story is told of an Englishman and a Frenchman who quarrelled over a trifle. Both were unwilling to fight—the Englishman because he didn't believe in risking his life, and the Frenchman because he was a bit afraid ; but their companions insisted on it. At last a place of meeting was arranged, and it was agreed that they should fight alone in a dark room with pistols. The candles were put out, and the combatants left to settle the little matter. The Englishman, to make sure of not being hit, and in order not to hit his antagonist, fired up the chimney. When lights were brought in by the seconds, it was discovered that the Englishman had brought down the Frenchman, who had climbed the flue to escape being fired upon !

418.

How an Apple got its Name.—Most folk like Ribston pippins, but few know the origin of this funny-looking name. Long ago a nobleman, so the story runs, had three apple pips sent to him from Rouen in France. It may be supposed that they were the seeds of a very fine kind of apple, for the nobleman took the trouble to plant them in the garden of his house at Ribston in Yorkshire. Two of the pips died, but from the third were derived all the Ribston apple-trees in England. The fruit was called *Ribston*, from its English birth-place, and *pippin*, from the original pip that was sent over from Normandy.

419.

A Child's Presence of Mind.—A little girl a few years ago went to the evening service at a church in the North of Devon. She took a seat in a high, old-fashioned pew in the gallery, and during the sermon fell soundly asleep. So sound, indeed, were her slumbers, that, the service ended, the congregation retired, the lights were put out, and the doors were closed and locked, and still she slept on. The parents of the little girl became alarmed when supper-time arrived and their daughter did not return. At eleven o'clock in the night, friends went in search, and the public bell-man announced the strange disappearance. At midnight, however, a bell in the belfry was heard to toll, and upon the sexton going to ascertain the cause, he found the little maiden taking that means of summoning aid. It was considered a wonderful instance of bravery and presence of mind for a girl under eleven years of age.

420.

The Wanderer's Return.—Twenty-five years ago a boy was sent for a pint of milk. He hid the can beneath a stone, directed his course to the nearest port, shipped as a cabin-boy, and went to sea. Years went by, and he was given up for dead; he was amassing vast wealth—a common thing, by the way, with sailors. The other day he returned, found the can where he had hid it, procured a pint of milk, and went to his boyhood's home, entered and said: 'Father and mother, here's your milk.' He was given a warm welcome, but he noticed there was a change in his parents' appearance; they had not the old familiar look. He questioned them, and explanations followed, through which, though they were still his parents, the change in their appearance was accounted for. Shortly after his departure from home his father died, and his mother married again; then his mother died and his new father married again. Thus, on his return, he found the old home as he left it, the only difference being that he had a new father and mother.

421.

The Petersburg Miser.—A Russian merchant, who was immensely rich, used to live in a small obscure room at St. Petersburg, with scarcely any fire, furniture, or attendants, though his house was larger than many palaces. He buried his money in casks in the cellar, and was so great a miser that he barely allowed himself the common necessaries of life. He placed his principal security in a large dog of singular fierceness, which used to protect the premises by barking nearly the whole of the night. At length the dog died; when the master, either impelled by his avarice from buying another dog, or fearing that he might not meet with one that he could so well depend on, adopted the singular method of performing the service himself, by going his rounds every evening, and barking as well and as loud as he could in imitation of his faithful sentinel.

422.

Regular Bricks.—On a certain occasion an ambassador, on a diplomatic mission, was shown by a certain king over his capital. The Ambassador knew of the monarch's fame, and he looked to see massive walls rearing aloft their embattled towers for the defence of the city, but found nothing of the kind. He marvelled much at this, and spoke of it to the king. 'Sire,' said he, 'I have visited most of the principal towns, and I find no walls reared for defence. Why is this?' 'Indeed, Sir Ambassador, thou canst not have looked carefully. Come with me to-morrow morning and I will show you the walls.' Accordingly, on the following morning, the king led his guest out upon the plain, where his army was drawn up in full array, and pointing proudly to the patriot host, he said: 'There thou beholdest the walls—10,000 men, and every man a brick.'

423.

A Faithful Animal.—A king, in ancient days, being wounded in battle, fell from the back of his elephant. The enemy, supposing him dead, pushed forward in order to despoil him of his rich clothing and accoutrements; but the faithful elephant, standing over the body of his master, boldly repelled every one who dared to approach, and while the enemy stood at bay, took the bleeding king up with his trunk and placed him again on his back. The king's troops came by this time to his relief, and thus the king was saved; but the poor elephant died of the wounds which it had received in the heroic defence of its master.

424.

Theft by a Cat.—A cook was greatly perplexed by the disappearance day after day of a chop or steak from the kitchen, when she was preparing the dinner. Every day there was one missing. She noticed that each day the kitchen bell was rung about the same time that she missed the meat, and she supposed there must be some connection between the two occurrences. She determined to watch. The bell rang at the usual time, but instead of answering it she hid herself in a cupboard. She had hardly done so before a cat rushed into the kitchen, sprang on the table, seized a steak in its mouth, and vanished. The cook found out that the cat had watched her put the meat on the kitchen table and then crept stealthily towards the handle of the bell, given it a furious pull, rushed into the kitchen, and committed the theft which she had witnessed.

425.

A Knowing Dog.—A grocer in Edinburgh had a dog, who often astonished and amused the people in his neighbourhood. A man, who frequented that street, ringing a bell and selling meat-pies, took it into his head, one day, to treat this dog with one. The next time the dog heard the bell, he rushed after the pieman and seized him by the coat, begging, by his looks and manner, for another treat. The pieman, who quite understood him, showed him a penny, and pointed to his master, who stood at the street-door watching what was going on. The dog at once left the pieman, and went to his master with entreating looks. His master gave him a penny, which he immediately carried to the pieman and received the expected treat. The traffic, once begun, went on for a long time, to the great amusement of the neighbours, and the entire satisfaction, both of the clever dog and the pieman.

426.

An Easy Escape from a Bear.—If often proves useful to know the habits of animals. It is a habit of bears to carefully examine any article they have not seen before. A sportsman who was hunting among the hills was chased by a bear. He had no powder, and was therefore forced to run, but the bear gained on him fast. Remembering this peculiarity of the bear, he threw a glove behind him. Bruin stopped to examine it, and in doing so, turned it inside out. This gave the sportsman time to get out of the way, and the bear gave up the chase.

427.

A Nugget of Gold.—One day, about thirty years ago, three men were sitting talking together in a small gold-mine in Australia. For some months they had been working in the mine, and had made barely enough to supply themselves with food. After talking the matter over, they determined to leave the mine and go and seek their fortunes elsewhere. One of them looked round the mine, and said: 'Good-bye, I will give you a farewell blow before we leave.' He raised his pick and struck the rock with it, making the splinters fly in all directions. All at once he saw a glittering speck on one of the bits at his feet. He called to his mates, and when they had examined the rock, they worked at it in silence with their picks for a long time. They had discovered a monster nugget of gold, and when they had taken it out of the rock, the men were almost wild with joy. They carried it in safety to the bank, and obtained for it a sum of £6,000.

428.

Anecdote of an Owl.—A Swedish gentleman, residing on a farm near a steep mountain, where two great eagle owls had their nest, gives an account of how one of the young owls was one day captured by his servants and shut up in a large hen-coop. The following morning he found a young partridge lying dead before the door of the coop; he at once concluded that it had been brought there by the old owls, who had found out where the young one was confined. For fourteen nights the same thing happened. Game was regularly brought by the old birds, but when the gentleman and his servants watched, the owls were cunning enough to discover it, and did not come near. But when no one was watching they did not fail to come. In August, which is the time when all birds of prey leave their young ones to take care of themselves, the parents ceased to make their visits.

429.

A Shrewd Parrot.—A grey parrot, very fond of an egg boiled hard, had on one occasion some of its favourite food given to it which was rather too hot, and for some time afterwards seems to

have been very suspicious of every egg placed before it ; and as it did not wish, apparently, to discard that kind of food altogether, it at length hit upon a novel expedient in order to prevent its bill being again hurt. After looking wistfully at the egg put before it, its habit now was to take in its beak some leaves of chickweed or other green food, and placing the egg sandwich fashion between two layers of this, it would then eat it, and thus save itself from being injured by too hot a meal. After a while it appears to have began to relish the strange mixture, and it now invariably, whether the egg be hot or cold, adopts this method of feeding.

430.

A KNOWING BIRD.—A gentleman who has recently returned from Mexico, brought with him a parrot named Jocko. It happened that for several days after his arrival the perch stood close beside an electric bell. When this was touched Jocko took notes, with his head on one side and a most inquiring air ; and, when the servant appeared immediately afterwards, Jocko gave a faint croak of astonishment. After witnessing this performance several times, it was evident that Jocko began to see some connection between the button and the servant. He spent a good deal of time studying the button, running his beak softly around it, and apparently communing with himself, his mistress watching him meanwhile, highly amused at his cleverness. At last, whether accidentally or otherwise, Jocko discovered the connection and pressed the button. The next moment a servant appeared, and the little schemer said with great gravity, 'Jocko's hungry.' His mistress's shouts of laughter and the servant's astonishment did not in the least discompose him. He had rung for what he wanted, and he insisted on having it. The scheme worked well, to Jocko's manifest delight.

431.

BLIND DASH.—Dash was not a full-blooded collie, but he was a fine dog and remarkably intelligent. He was early trained to drive the cows to and from the pasture. One afternoon when the cows came home one was missing. 'Where's Brindle, Dash?' his master inquired. The dog looked despondent, he hung his head and drooped his tale as if with shame. 'Go find Brindle,' commanded the master. Dash turned and ran for a few steps in the direction of the pasture, and then trotted slowly back as if to say, 'It's no use. I've tried, but I can't get that cow.' At his master's repeated command he again ran off for a few steps, but returned as before, this time whining uneasily. 'Something wrong, is there, old dog? Well, I'll go along and see,' said the man, and he started in the direction of the pasture. A wonderful change came over Dash at this move of his master. Wide awake and tail wagging he led the way, with occasional sharp expressive barks. Without a moment's hesitation he led his master straight to the spot where old Brindle stood, and then began barking vociferously, as much as to say, 'There, you see how it is? I couldn't start her.' The cow had caught her head in the crotch of an apple tree. She had been reaching for apples, and, having put her head in the crotch from above, was unable to withdraw it, and there she hung, a picture of stupid misery, in imminent danger of choking to death. She was released, after considerable difficulty, and Dash drove her home. He had saved her life, his master thinks, for she could hardly have lived through the night in such a position.

432.

AN INCIDENT OF WATERLOO.—One of the most stoutly defended places on the field of Waterloo was a farmhouse, with an orchard surrounded by a thick hedge. Our soldiers were told to hold it against the enemy at any hazard and any sacrifice. The French were beaten back many times, but at last the powder and ball were running short, the hedges had taken fire, and the orchard was surrounded by a ring of flame. A messenger had been sent for more ammunition, and soon two loaded waggons neared the spot. The driver of the first, with the reckless daring of an English boy, spurred his horses through the burning hedge, but the flames caught the powder, and in an instant horses, waggon, and driver were blown into fragments. The second driver was appalled, but seeing that the shock had beaten the flames back he dashed his horses at the breach, and, amid the deafening cheers of the garrison; landed his terrible cargo safe within. The Duke of Wellington is said to have spoken of this as one of the bravest deeds of the whole battle.

433.

A CLEVER DOG.—A farmer who had sold a flock of sheep to a dealer, lent him his dog to drive them a distance of thirty miles, desiring him to give the dog a meal at the end of the journey, and tell it to go home. The drover found the dog so useful that he made up his mind to steal it, and instead of sending it back he locked it up. The collie grew sulky under this treatment, and at last effected its escape. Evidently thinking the drover had no more right to keep the sheep than he had to detain itself, the honest creature went to the field and collected all the sheep that had belonged to its master. It then drove the whole flock back again, where they arrived safely to the great astonishment of the farmer.

NEW READING TESTS.—STANDARD III.

Suitable for 'Unseen Tests' in Dictation also.

297.—As a matter of fact no boat did appear, but something else happened which answered almost as well. The sea grew calmer and ceased to dash against the rock, and when day dawned the imps found to their surprise that the tide had gone out, and that they were surrounded by a belt of wet shining sand. Needless to say, they lost no time in making their way to the shore.—(H.M.I.'s Test.)

298.—As we entered the building a workman, dressed from head to foot in a stout leathern suit, and wearing heavy spectacles to protect his eyes from the scorching heat, flung open an enormous furnace door. Out rushed a stream of golden, ruddy light, so bright as to almost hurt one's eyes to look at it—and oh, how hot !—(H.M.I.'s Test.)

299.—A group of workmen then swung forward an immense pair of claws, like a giant might use for sugar-tongs, and these were thrust into the burning furnace, where they seized upon a huge lump of glowing metal, and, swinging slowly round, placed it carefully upon the anvil beneath the powerful hammer that, with enormous force, rapidly descended.—(H.M.I.'s Test.)

300.—They were funny looking fellows, for they had their tall white hats crooked, and their clothes were striped red and blue, and the points of their collars stuck out for at least ten inches high at each side of their faces. But when they saw themselves nearly overtaken by the clowns, they turned and ran up the road at the top of their speed.—(H.M.I.'s Test.)

301.—He pushed his two little sisters on one side so roughly that they both fell against the clothes-horse, and then in turn fell right on to the top of the fire, and before Bob could even realise what he had done, the newly-ironed garments were alight, and a bright flame springing out caught the curtain that hung around the mantel-shelf, and set that also blazing. —(H.M.I.'s Test.)

302.—On the whole he found it quite as pleasant to amuse himself in a way that other people did not have to pay for, and he saw that, as a boy grows older, pranks that are amusing enough when he is little, and offences that are easily overlooked for a time become less excusable, and should be outgrown with the advance of years.—(H.M.I.'s Test.)

303.—It was a hot evening just in the beginning of September, and the two little boys were at play in the park, beyond the light iron fence which divided it from the garden. Tommy was bowling to Lionel with more zeal than skill, and the gardener's little son was posted near to run for the balls, as Lionel found playing quite hot enough, and Tommy was always too lazy to run.—(H.M.I.'s Test.)

304.—And without the slightest warning the panther's great head and shoulders appeared through a wide crack not twenty feet from us, and with a loud and angry snarl he bounded towards us. He was a very handsome spotted

fellow, fierce and powerful, but far too near us, for we saw his great white teeth ready to bite and tear us, and his strong paws ready to knock us over.—(H.M.I.'s Test.)

305.—He saw that he must show his nobility, not in grand display or in self-indulgence, but by being a good man, a kindly gentleman, generous and upright in his dealings, and a pattern to those about him who had less than he had and fewer advantages, and would look to him to set them an example of what an English country gentleman should be.—(H.M.I.'s Test.)

306.—It was a fine, hot summer, and the boys were allowed more liberty than they had ever had before, partly because Lionel was really very careful when in charge of his little brother, partly because it was thought on all hands that the poor children would not long enjoy their freedom, and that they might just as well make the most of it while it lasted.—(H.M.I.'s Test.)

307.—All at once he stumbled, his foot slipped from beneath him, and he found himself flying downward like an arrow, amid a cloud of whirling dust and crushing gravel. Then suddenly he felt himself shot out into the empty air, as if flung from the brow of a precipice. His headlong course was arrested all in a sudden, and he felt himself buried up to the knees in a mass of soft wet mud.—(H.M.I.'s Test).

308.—George's first impulse, on finding that he had escaped with unbroken bones, was to laugh heartily at this curious ending of his perilous fall. But he soon found to his cost that it was no laughing matter. Struggle as he might it was all in vain that he tried to withdraw his feet from the clinging mud, which held them as firmly as the teeth of a crocodile.—(H.M.I.'s Test.)

NEW DICTATION TESTS.—STANDARD IV.

Suitable for 'Unseen Tests' in Reading also.

No. 308.

THE trading rat is one of the most interesting animals met with in the Rocky Mountains. The miners of that region declare that, although these rats enter houses, camps, and mines for the express purpose of getting things that do not belong to them, they never take an article without leaving something in its place. They conduct a trade, and hence their name. They enter dwellings at night, and steal anything they can find, carrying away spoons, knives and forks, but invariably leaving a chip or stone in the place of each article they take away.

No. 309.

THE birds of Australia have no song, and such notes as they possess seem like weird echoes from a period when reptiles were assuming wings and filling the tree tops with a strange jargon, before heard only in the swamps and fens. The flowers have no scent, while the leaves of every tree are full of odour. The trees cast no shade, since every leaf is set at edge against the sun, and shed, not their leaves, but their bark, which, stripping off in long scales, exposes the naked wood beneath, and adds to the ghostly effect.

No. 310.

WHEN you wish to know what the weather is going to be, go out and select the smallest cloud you see. Keep your eye on it, and if it decreases and disappears it shows a state of the air that is sure to be followed by fine weather; but if it increases take your overcoat with you if you are going away from home, for falling weather is not far off. The reason is this. When the air is becoming charged with electricity you will see every cloud attracting all lesser ones toward it until it gathers into a shower, and, on the contrary, when the fluid is passing off or diffusing itself, then a large cloud will be seen breaking into pieces and dissolving.

No. 311.

THERE is a very pretty practice which the Fishmongers' Company have at their Court dinners. The ladies being absent from the feast, each guest on his departure is offered the acceptance of a handsome casket of choice sweets to take home to his wife and family. The outside box serves for a workbox, and is for years a pleasant memento of the occasion.

No. 312.

AN ingenious general information machine has been set up in a railway station of Melbourne. By pressing different electric buttons the following, among other things, will appear: A list of the best hotels in the city, a list of the plays at the theatres, with their play bills, a list of omnibus routes, and the cab fares to the various points of interest. The principle of the machine is capable of indefinite expansion.

No. 313.

A COLONIAL newspaper notices an amusing instance of the manner in which railway trains are sometimes stopped. The engine-driver of a fast express observing an elderly lady waving her hand at a siding where the train was not timed to stop, as if she wished 'to get on board,' slowed up, only to discover that the lady wanted to know if any passenger had change for a bank-note!

No. 314.

THE difference between a tramp and a traveller is that the traveller is going somewhere and the tramp is not. He who is living a purposeless life is virtually a tramp, and by as much as a person's life-purpose is below that of being and doing what God intended he should do and be, by just so much is that person removed from the true man towards the tramp.

No. 315.

THE Chinese bury their dead in the fairest spots in the land. They are very devoted to the dead, and the labour contract of every emigrant specially stipulates that in case of death his body shall be carried back to China that his dust may mingle with that of his forefathers, and join their spirits in the flowery kingdom. Otherwise, he believes that his soul will wander amid strangers unknown and astray.

No. 316.

A MILE down, the water has a pressure of a ton on every square inch. If a box six feet deep were filled with sea water and allowed to evaporate, there would be two inches of salt left on the bottom of the box. Taking the average depth of the oceans of the world to be three miles, there would be a layer of salt 230 feet thick over the entire bed should the water evaporate. The water of the ocean is colder at the bottom than at the surface. In many places, especially in the bays on the coast of Norway, the water freezes at the bottom before it does above.

No. 317.

ACTIVITY, without overwork, healthful living, moderation, self-control, the due exercise of all the faculties, the cultivation of the reason, the judgment, and the will, the nurture of kindly feelings, and the practice of doing good—all things, in fact, which tend to build up a noble manhood—also prepare the way to a long life and a happy and blessed old age.

No. 318.

LAUREL is a name given to several kinds of shrubs. The true laurel belongs to the south of Europe. It is an evergreen, with beautiful glossy leaves, and bears black berries about the size of wild cherries. This is the laurel used for crowns, and the custom of crowning poets with it gave rise to the title 'poet laureate.' It is sometimes called the sweet bay tree, and its fruit the bay-berry. Bachelors of arts used to wear a wreath of bays or bay-berries when they were given their degree.

No. 319.

WHEN a young lion reaches the age of two years he is able to strangle or pull down a horse or an ox; and so he continues to grow and increase in strength till he reaches his eighth year, when he grows no more. For twenty years after his fangs and talons show no signs of decay; but after that he gradually becomes feeble, and his teeth fail him.

No. 320.

ONE of the most curious of the sea monsters is certainly the blanket-fish. It is of a dark brown colour, with a lavish sprinkling of black specks distributed over its surface. Its weight runs to about five-and-twenty pounds, and, spread out, it measures six feet long by five feet wide, while it is never more than an inch in thickness. When about to make a capture it wraps itself round its victim, and, by impeding all struggles for freedom, causes it to drown. It then keeps it in that position until it is digested.

No. 321.

IN summer the squirrel is concealed among the dense roof of green. And now, when trees are growing bare, and the screen is falling from his airy highway, he is so like the withered oak and beech leaves, that, when he is still, it is no easy matter to discover him. He knows it well. Move towards him, ever so slowly, his keen eye will catch sight of the moving figure. He crouches flat on a level bough, or clings to the tree trunk as still as if he were a very part of it. Truly a forester born!—(H.M.I.'s Test.)

No. 322.

A MOST ingenious system is employed by which the Director of the Suez Canal can tell at a glance the exact position of all vessels passing through it. A model is placed in the office, and the whole canal is worked from headquarters by means of the telegraph, the position of each ship being marked by a figure on the model. It is thus made easy to arrange for vessels passing each other.

No. 323.

THE spacious firmament on high,
With all the blue ethereal sky,
And spangled heavens, a shining frame,
Their great Original proclaim.
The unweary'd sun, from day to day,
Does his Creator's power display,
And publishes to every land
The work of an Almighty hand.

STANDARDS V.—VII., AND 1ST & 2ND YEAR P.T's.

Suitable for 'Unseen Tests' in Reading also.

No. 280.

THE thimble was originally called a thumb bell by the English, because worn on the thumb, then a thumble, and finally its present name. It was a Dutch invention, and was first brought to England in 1695. Thimbles were formerly made only of iron and brass, but in comparatively late years they have been made of gold, steel, horn, ivory, and even glass and pearl. In China beautiful carved pearl thimbles are seen, bound with gold, and with the end of gold. The first thimble introduced into Siam was a bridal gift from the King to the Queen; it is shaped like a lotus bud, made of gold, and thickly studded with diamonds arranged to spell the Queen's name.

No. 281.

THE crocodile and the alligator are not just the same variety of reptile with different names, as is sometimes imagined. There are certain well-marked differences between them. For instance, in the crocodile the toes are completely webbed, and each of the hind legs has a toothed fringe, while in the alligator the hind legs are simply rounded, and the feet are not completely webbed. Moreover, in the former, one of the canine teeth of the lower jaw is always visible when the mouth is shut, but is perfectly hidden under the same conditions in the alligator. The crocodiles inhabit the rivers of tropical Africa, Asia, and Australia, whilst the alligators are found in America.

No. 282.

IT has been proved during a series of observations, extending over five years, by an American naturalist, that the Frigate Bird can remain for a week in the air without touching land or water, and here we have a feat of endurance equally unparalleled, for, during every second of the time, the bird must be exerting some energy to keep itself afloat. It has been calculated that birds generally can continuously exert three times the horse-power per pound of body weight that the strongest men or horses can, and in the case of the Frigate Bird the proportion is even higher.

No. 283.

THERE is, perhaps, no better test of a man's real strength and character than the way in which he bears himself under just reproof. Every man makes mistakes; every man commits faults, but not every man has the honesty and meekness to acknowledge his errors, and to welcome the criticism which points them out to him. It is rarely difficult for us to find an excuse for our course, if it is an excuse we are looking for. It is, in fact, always easier to spring to angry defence of ourselves than to calmly acknowledge the justice of another's righteous condemnation of some wrong action of ours; but to refuse to adopt this latter course, when we know that we are in the wrong, is to reveal to our own better consciousness, and often to the consciousness of others, an essential defect in our character.

No. 284.

THE jay is the most persistent practical joker in the feathered kingdom. He will conceal himself in a clump of leaves near the spot where small birds are accustomed to gather, and when they are enjoying themselves in their own fashion, will suddenly frighten them almost to death by screaming like a hawk. Of course they scatter in every direction, and when they do, the mischievous rascal gives vent to a cackle that sounds very much like a laugh. If he confined his pranks to such jokes as this, however, he would not be such a bad neighbour to birds smaller than himself, but when he amuses himself by breaking the eggs in their nests, and tearing the young to pieces with his bill, he becomes a pestilent nuisance, and they often combine their forces to drive him out of the neighbourhood.

No. 285.

ONE of the most curious natural productions of the West Indies is the famed vegetable fly, an insect about the size and colour of a drone bee, but without wings. In the month of May it buries itself in the earth and begins to vegetate. By the beginning of June a sprout has issued from the creature's back and made its appearance above the surface of the ground. By the end of July the tiny tree (known on the island as the fly-tree) has attained its full size, being then about three inches high, but a perfect tree in every particular, much resembling a delicate coral branch. Pods appear on its branches as soon as it arrives at its full growth. These ripen and drop off in August. Instead of containing seeds, as one would naturally suppose, these pods have from three to six small, hard worms upon the interior.

No. 286.

THERE are no qualities which succeed so well in this world as selfishness and strict honesty. It pays to be honest. There is nothing heroic about it. And there is nothing heroic about the success of the self-made man who takes all his chances and leaves his younger brothers and sisters to shift for themselves. The young man who stays at home in order to help those near him to rise from the slough of poverty is the hero. He is unselfish. We cannot gauge success by what appears to be success. If money making were the real test of success we should have no heroes. We should have no priests, no religions, no philanthropists, no poets, no orators. That man is truly successful and truly heroic who strictly performs his duty. The man who strains every nerve and sinew to make money is laying up for himself an old age of regret.

No. 287.

IT is astonishing how many people there are who neglect punctuality. Thousands have failed in life from this cause alone. It is not only a serious vice in itself, but it is the fruitful parent of numerous other vices, so that he who becomes the victim of it gets involved in toils from which it is almost impossible to escape. It makes the merchant wasteful of time; it saps the business reputation of the lawyer; and it injures the prospects of the mechanic, who might otherwise rise to fortune; in a word, there is not a profession nor a station in life which is not liable to the canker of the destructive habit.

No. 288.

AMONG the wares which farmers in the South of Europe bring to market are bunches of mulberry leaves. They are purchased by people who keep silk-worms, and who have not the means on their own ground for feeding them. The leaves are sold by weight in the market; and to select what will feed the worms best is a task of some difficulty. The farmer wants to sell the heaviest, but the purchaser knows that as the trees grow older the leaf gets smaller, and that it is the small leaf which contains most food. Those who do not buy in the markets hire mulberry trees in nurseries and plantations for the season, a good tree giving from 30 lbs. to 60 lbs. of leaves. The price of a tree varies according to the local demand for it; but between 6s. and 7s. would not be considered too much for one yielding 30 lbs. of leaves.

No. 289.

FEW people appear to be aware that a tooth can be extracted, cleaned, and restored to its socket, and become again a useful and natural instrument. One Liverpool dentist, at least, is in the habit of doing such a thing; and it appears to surprise most people. A gentleman in a large shipping office had a tooth taken out, cleaned, and restored some years ago, and it is at the present time a good serviceable tooth. This suggests the question as to the possibility of extracting old teeth and inserting new ones. It would be a boon to many, and is worth considering by clever dentists.

No. 290.

WHEN an Arab woman intends to marry again after the death of her husband, she comes, in the night before her second marriage, to

the grave of her dead husband. Here she kneels and prays to him, and entreats him 'not to be offended—not to be jealous.' As, however, she fears he *will* be jealous and angry, the widow brings with her a donkey, laden with two goat-skins of water. Her prayers and entreaties done, she proceeds to pour on the grave the water, to keep the first husband cool under the irritating circumstances about to take place; and having well saturated him, she departs.

No. 291.

Oh! never let us lightly fling
A barb of woe to wound another;
Oh! never let us haste to bring
The cup of sorrow to a brother.
Each has the power to wound; but he
Who wounds that he may witness pain
Has spurned the law of charity,
Which ne'er inflicts a pang in vain.

Good is it to awaken joy,
Or sorrow's influence to subdue—
But not to wound, or to annoy,
Is part of virtue's lesson too.
Peace that is born in worlds above,
Shall lend her dawn to brighten this;
Then all man's labour shall be love,
And all his aim his brother's bliss.

COMPOSITION TESTS.—STANDARDS VI. & VII. AND 1ST & 2ND YEAR P.T'S.

Write at least 20 lines on ONE of the following:—

113. Select points in the character of any great public man you are acquainted with.
114. If you were going to emigrate, to what country would you go, and why?
115. A comparison of the leading features of the English and Scotch character.
116. The importance of Thrift, and the uses of Savings Banks.
117. 'Fire is a good servant, but a bad master.'
118. The pleasures of Autumn.
119. 'A rolling stone gathers no moss.'
120. The postal service of this country.
121. A letter to your grandfather on your hopes and intentions in the future.
122. Travelling in foreign countries.
123. A letter applying for a situation as monitor in a school, or nursemaid.
124. Describe how you spent your summer holidays.

NEW PROBLEMS IN ARITHMETIC.

(SECOND SERIES.)

BY T. B. ELLERY, F.R.G.S.,
President of the National Union of Teachers.

7TH PAPER.

STANDARD II.—(1895 CODE).

THE first series having been well received, and the Editor's wish being law, the present series is submitted in the hope that teachers—especially the young and inexperienced—may derive some assistance in their heavy labours.

As I have said before, a number of the exercises may be found beyond some of the children in the Standard, but each will form the basis of a good lesson, and the whole set, carefully worked on the blackboard and by the children, will give excellent practice and help considerably in the preparation for more advanced work.

For introduction see *The Practical Teacher* for October 1894, and for further particulars *The Girls' Mistress* for September 1st, 1894, in which issue appeared the first of a series of papers entitled *Standard Problems for Girls, and How to Solve them.*

The second series began with a set of tests for Standard III., and is now complete.

A.

1. Divide the difference between five thousand and eighty and 2,893 by the difference between twenty and eleven.

2. What must you add to the sum of 3,085 and eleven hundred to make ten thousand?

3. What is the ninth part of the difference between 352 and nineteen?

4. How many dozens are there in 480 × 17?

5. A man walked 45 miles on each of three days and 36 miles on the fourth day. How many miles did he walk in all?

6. There are 36 boys and 38 girls in a certain class. A gentleman gives two buns to each of them. How many buns does he give away?

7. A man earns 40 pence a day and a boy 18 pence. How many pence will they together earn in six days?

8. If I can buy 8 marbles for a penny, how many can I buy with sixpence half-penny?

9. How many dozens are there in the difference between 46,809 and 60,213?

10. I bought 250 sheep, then 308, and then four hundred. I sold 5 score. How many left?

11. A woman had 5 dozen eggs in each of two baskets, and 3½ dozen in another. How many in all?

12. A boy had 16 pens and his sister had 28. They gave away half a dozen. How many had they together then?

B.

13. I bought 250 apples on Monday and 316 on Tuesday. On Wednesday I bought as many as on Monday and Tuesday together. How many did I buy altogether on the three days?

14. I sold four hundred and sixty oranges on each of 3 days and 250 on the fourth day. How many did I sell in all?

15. Mary bought 16 buns, Emily bought eight more than that number, and Rose bought two dozen. How many did they buy altogether?

16. How many oranges at a penny each must I give in exchange for two hats at two shillings each?

17. A man bought 84 hats and then 120 more. He sold them in half-dozens. How many half-dozens did he sell?

18. A woman bought 68 pears, then 34, and afterwards 28. To how many girls could she give five each?

19. A fruiterer had 460 oranges. He kept 256, and divided the remainder equally among 4 men. How many had each man?

20. A man bought 265 buns at one shop and 323 at another. To how many children could he give three each?

21. I have 390 sovereigns in four bags. In the first I have 85 sovereigns, the same number in the second bag, and in the third I have 120. How many have I in the fourth?

22. I had two hundred apples. I gave fifteen to each of nine men. How many left?

23. A farmer bought 184 sheep and sold 98 of them. He then bought 136 more. How many had he then?

24. A gentleman gave forty-eight nuts to each of two boys, and half that number to a girl. How many did he give away?

25. Find the sum of (635 + 86), (704 − 186), and (56 × 9).

26. How often is the difference between fifty-six and forty-seven contained in sixteen thousand and eighty-three?

27. Take thirty dozen from thirty-five score, and divide the result by four.

28. A lady gave a penny to each of 28 boys and twopence to each of thirty boys. How many pennies did she give away?

C.

29. I have five bags of nuts. In each of two of them there are 160 nuts, and in each of the others 180 nuts. How many nuts in all?

30. I buy 60 apples at 3 a penny, and 42 oranges at 2 a penny. How many pennies do I spend?

31. I had five hundred marbles. I gave eighteen to each of eight boys, and twenty-four to each of twelve others. How many had I then?

32. John has eight pennies in his pocket, Fred has twice and Harry three times that number. How many had they in all?

33. A woman had 4 baskets in each of which were 220 oranges, and 3 other baskets in each of which were 175 oranges. How many had she in all?

34. I gave 16 nuts to each of four girls and 14 to each of five boys. How many did I give away?

35. If a certain book cost three shillings and a knife two shillings, what would you pay for eight books and eight knives?

36. A boy bought marbles at fourteen a penny. How many did he buy with one shilling and threepence?

37. By how much is 60 × 9 greater than 2506 ÷ 7?

38. I bought 130 apples. I kept 86 for myself and divided the remainder equally among eleven men. How many did each man receive?

39. What must you multiply twelve by to obtain a result equal to 36 × 18?

40. A gentleman gave Tom eighty-four apples and Harry fifty-six apples. How many must Tom give Harry that one may have as many as the other?

41. A man had 460 apples in one sack and 320 in another. He divided them equally among eight men and four women. How many did each receive?

42. A fruiterer had 370 apples. He placed ten of them in a bag and the rest he placed in bags, each holding twelve. How many bags were used in all?

43. A fruiterer had six hundred and forty oranges. One-half of these he placed in bags holding 8 each, and the rest in bags holding 10 each. How many bags were used?

44. A man divided four hundred and twenty apples between two men, giving one man forty more than the other. How many did each receive?

45. What is the nearest number greater than 189 which is exactly divisible by eleven?

ANSWERS.

(1) 243.
(2) 5,815.
(3) 37.
(4) 680 dozens.
(5) 171 miles.
(6) 148 buns.
(7) 348 pence.
(8) 52 marbles.
(9) 1,117 dozens.
(10) 858 sheep.
(11) 162 eggs.
(12) 38 pens.
(13) 1,132 apples.
(14) 1,630 oranges.
(15) 64 buns.
(16) 48 oranges.
(17) 34 half-dozens.
(18) 26 girls.
(19) 51 oranges.
(20) 196 children.
(21) 100 sovereigns.
(22) 65 apples.
(23) 222 sheep.
(24) 120 nuts.
(25) 1,743.
(26) 1,787 times.
(27) 85.
(28) 88 pennies.
(29) 860 nuts.
(30) 41 pennies.
(31) 68 marbles.
(32) 48 pennies.
(33) 1,405 oranges.
(34) 134 nuts.
(35) 40 shillings.
(36) 210 marbles.
(37) 182.
(38) 4 apples.
(39) 54.
(40) 14 apples.
(41) 65 apples.
(42) 31 bags.
(43) 72 bags.
(44) 190; 230 apples.
(45) 198.

LEGAL DECISIONS RELATING TO THE TECHNICAL INSTRUCTION ACTS.

FORTY-SECOND REPORT OF SCIENCE AND ART DEPARTMENT.

A. It is illegal for a local authority to

(1.) Apply funds, in the form of scholarships, or otherwise, in the training of nurses *to act professionally;*

(2.) Teach swimming, gymnastics, Swedish drill, and other forms of physical training as *subjects of technical instruction;*

(3.) Establish a station for fish hatchery outside its district;

(4.) Found exhibitions tenable by Queen's Scholars at day training colleges for the purpose of giving the scholars *a general education;*

(5.) Offer prizes for manual dexterity at an agricultural competition *apart from class instruction.*

B. It is legal for a county council to

(1.) Aid lectures for general instruction in nursing, open to all persons in the district;

(2.) Teach the science of common things, as long as it is covered by the subjects of the Directory;

(3.) Give instruction on the growth of the Colonial Empire, if in the main commercial history and geography;

(4.) Make grants to central classes in aid of the instruction in *technical* subjects of pupil teachers;

(5.) Award exhibitions on a competitive examination in the science and art of teaching;

(6.) Employ a rate, or local taxation funds, to erect a school or college for the purposes of technical education;

(7.) Award prizes to students in a class aided or conducted by the county council in science, art, or agricultural processes.

C. 'It is inexpedient.'

The *Plumbing difficulty:*

'It may be reasonably held to be undesirable to admit to certain kinds of technical classes those who have not the foundation of a workshop practice. If a number of amateurs were admitted to such classes, the teaching given would have to be distorted.'

Poverty test:

'There is no limitation in the Technical Instruction Acts with regard to the social position of students.'

TEACHERS' DRAWING LESSONS.

MODEL.

STANDARD VII.

BY E. BUFFERY RIDGE,
Head Master, Saffron Hill School of Art.

Cube Resting on One Corner.

IN this position there will be no edges or faces either vertical or horizontal—the model will *lean* against some support—see Fig. 3, where the cube rests on corner *d*, and leans to the left against the cylinder. In Fig. 1 the model leans towards the right, and the support is not shown.

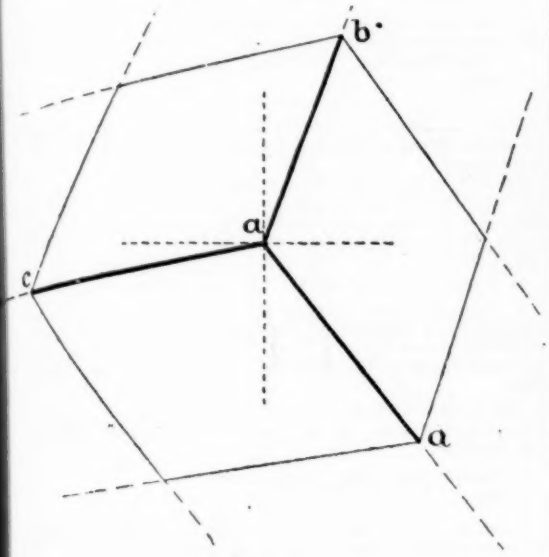

FIG. 1.

Fix the nearest corner *a* on the paper, and through the point draw a vertical and a horizontal line for purposes of comparison. The pencil held upright will show how much the edge *ab* deviates from the perpendicular, and the same angle should be made on the paper. The edge *ac* is nearly horizontal, and the pencil held horizontally will show a small angle downwards. The third of the three front edges *ad* should be tested both by the vertical and horizontal pencil to ascertain whether it bisects the right angle, or, if not, which way the difference lies.

Having drawn these three edges, of indefinite length, note if each of the three angles made by them is, as it should be, greater than a right angle.

Fix the length of one of them—at pleasure if drawing the cube only, and with regard to the other objects and the height of the eye-level if drawing a group—and get the lengths of the other two by comparison with the first and with each other.

The figure will then present the appearance shown in Fig. 1 by the three thick lines. Remember that these are not horizontal, and will not vanish into the eye-level—compare with the model for the proper amount of convergence and draw two lines to vanish with each of the three, *i.e.*, from *b* and *c* vanishing with *a d*, from *c* and *d* vanishing with *a b*, and from *b* and *d* vanishing with *a c*. These lines will complete the figure. Turn it about and see if from any point of view it looks out of shape.

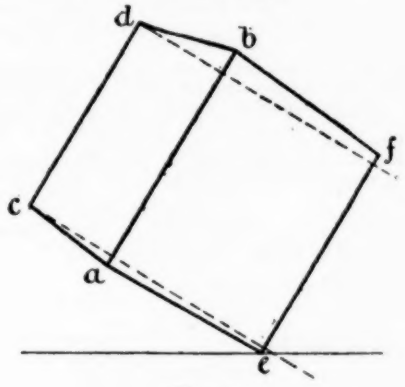

FIG. 2.

In Fig. 2 only two faces are seen—three of the lines will be parallel. The widths between them must be very carefully compared with each other and with the line *ab*. It is very easy to get them too wide—the total width from *c* to *e*, in an extreme case, is to *ab* as 7 to 5. This is seen when the two faces appear equal. The edge *cd* is then equal to *ef*. Compare them in Fig. 2, where the wider face is bounded by the longer edge. Notice the dotted lines drawn at right angles to *ab* to show at *e* and *f* that the extra length there (outside the dotted lines) is proportioned as at *a* and *b*.

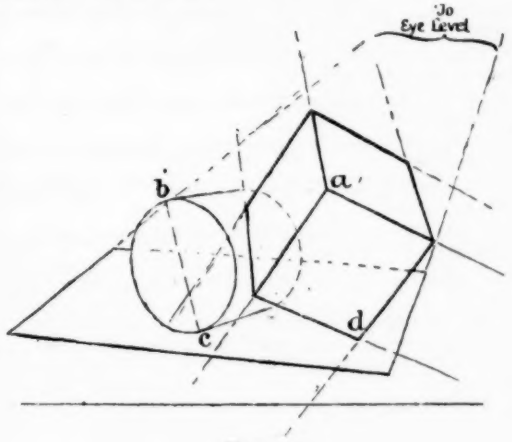

FIG. 3.

Drawing-board, cylinder, and cube.

Draw the board and the eye-level; fix point *a*, then the line *bc*, then point *d*. When drawing the slanting lines from *a*, occasionally hold up the paper so that the drawing and the group are seen side by side, and see if corresponding lines in the two are parallel. Be careful that the cube is tilted towards the side where it receives support.

OUR 1896 CERTIFICATE CLASS.

BY J. C. HOROBIN, M.A.,
Principal, Cavendish College, Cambridge.

FIRST YEAR—MEN.

Reading, etc.

Students should mark out a certain portion of the book they choose for reading, and the lines for repetition, and carefully look over for significant emphasis, phrasing, accent, etc., and then get their head teachers, or some well educated person, to hear them recite and read each week.

The full mark for reading is difficult to get, and cannot be got without much practice under criticism.

Penmanship.

Write in text hand and small hand :—

Vivisection.
Cambridge University.

Spelling.

Write from dictation :—

LANFRANC.

He was a man who would enter | heart and soul | into any work to which he was called by the providence of God, | but his tastes and inclinations were for private life | and for the humbler pursuits of learning. | He had unwillingly accepted the office of abbot. | He disliked the secular duties which devolved upon him. | He preferred to deal with books rather than with men | . . . With these feelings, | Lanfranc had quitted the legal profession | and the prospects which were opened to him in early life of being a statesman. | Under similar feelings, | he refused the important position | which the Metropolitan See of Rouen offered to his ambition as the head of the Norman Church ; | and he declined the invitation of William, | now King of England, | when in 1070 he offered him the archbishopric of Canterbury.—(DEAN HOOK.)

School Management.

1. What is a general principle? Explain fully what is meant by the statement : 'Concrete before abstract should be the rule for the teacher.'

2. What are the qualities of good reading in Standard III. and Standard VI. respectively.

3. Describe the phonic method of teaching reading, and discuss its value and defects.

4. What are the marks of a good lesson? Write notes of a lesson on Subtraction.

5. What do you understand by the phrase : 'Development of a faculty by exercise'?

6. What differences do you distinguish between an exercise for reading and one for spelling?

Give some simple rules for a pupil teacher giving a dictation exercise.

7. What special mental faculties are called into exercise in the study of the theory and in the practice of Arithmetic? What place would you give to Mental Arithmetic in a scheme of Arithmetic for Standard V.?

8. Explain fully what you understand by 'Attention.'

Composition.

Write a short essay on :—

(*a*) African exploration.
(*b*) The use of music in school.
(*c*) The various areas of local government.

Music.

1. State the major scale relation (as subdominant, etc.) of the following tones :—

(1) s (2) d' (3) f (4) r (5) t

2. Fill up two measures of each of the following kinds, showing rests and continuations in each example :—

(*a*) Two-pulse. (*b*) Four-pulse. (*c*) Three-pulse.

3. Write in figures over the following the value (as 1 pulse, ½ pulse, 1½, etc.) of each note and rest :—

| s :— | :-.f :m,f | s :-.l | r. : .m |
| f,s.l : s .d | r :d ||

4. Write the time names (as *taa*, or *taa-tai*, etc.) of the following pulses :—

(1) | l .,l : l || (2) | l :l .l || (3) | :l ||
(4) | l :-.l || (5) | l,l.l : l.l,l ||

5. Re-write the following in four-pulse measure, doubling the value of each note and rest :—

(1) | s .,f :m .d || (2) | r :- .m ||
(3) | f,s .l,t : d' .s || (4) | m . : .f ||
(5) | m,r .d : r .,d || (6) | d :— ||

6. State the meanings of the following terms, and give the words that express the opposite meanings :—

(1) Diminuendo. (2) Piano. (3) Staccato. (4) Accelerando.

English.

Gray. 1. Parse—'H. to A.' : (1) daughter, power, (4) affright, (6) taught, (10) virtue, child, (12) bad, (20) leisure to be, (21) light, (45) extinct.

'P. of P.' : (1) awake, (13) sovereign, (14) parent, (20) perching, (21) lulls, (22) wing, (25) Thee, (26) tempered, (31) frisking light, (32) pursuing, (35) feet, (38) that, (42) what, (48) say, (53) shafts, (56) broke, (64) pursue, (71) languish, (72) mute, (80) that, (95) sublime.

2. Analyse 'H to A.,' 25–32. 'P. of P.,' 83–94.

3. Comment upon : daughter of Jove, lore, Gorgon terrors, vengeful band, Æolian lyre, Helicon, Thracia's hills, Idalia, Hyperion, beyond the solar road, Delphi, Ilissus, Mæander, each old poetic mountain, the Nine, Nature's darling, coursers, Theban eagle.

Milton. 1. Parse—(p. 1, l. 6) reforming, (11) as, (p. 2, l. 6) transpose, (20) ruling, (21) working, (p. 3, l. 6) defer, (18) brief, (19) that.

2. Analyse page 4, lines 9–15.

3. Who was Hartlib?

Comment on : conjurements, argument, ought, defer, voluntary idea, Janua's and Didactics, the end then, etc.

Geography.

1. Give some particulars respecting India, as respects : (1) the races which inhabit it ; (2) its government ; and (3) its religion.

2. Say what you know of these places :—Lucknow, Port Elizabeth, Ottawa, Poonah, Brisbane, the Punjaub, St. Helena, Winnipeg, the Fiji Islands, Barbadoes, Penjdeh.

3. Explain what is meant by the Dominion of Canada, and give some account of its origin and constitution.

4. Who are the Bushmen, the Red Indians, the Cingalese, the French Canadians, and the Sikhs respectively?

5. Give some account of the plants and animals found in Australia.

6. From what British Possessions do we obtain maize, quinine, rice, diamonds, hides, jute, ostrich feathers, teak, and wool?

History.

1. What were Magna Charta, the Constitutions of Clarendon, Habeas Corpus Act, and the Covenant?

2. Who were the chief soldiers, statesmen, and men of letters in the time of George III.?

3. Narrate the circumstances which led to the revolution of 1688.

4. Name Elizabeth's chief advisers and courtiers ; and enumerate the most memorable events which took place in England in her reign.

5. What were the chief maritime enterprises and discoveries of the Tudor period?

6. What was Henry VII.'s claim to the throne? What were the principal discoveries at home and abroad in his reign?

Arithmetic.

1. At a school divided into four classes, $\frac{1}{4}$ of the children are in the first, $\frac{3}{14}$ in the second, $\frac{5}{18}$ in the third, and in the fourth 6 children more than half the number in the first three. Find the whole number.

2. Simplify $\dfrac{7\frac{2}{5}\times 7\frac{2}{5}\times 7\frac{2}{5}-27}{7\frac{2}{5}\times 7\frac{2}{5}-9}$.

3. A merchant lays out £1,000 in buying cloth in England at 3s. per yard. He takes the cloth to France at an expense of 3d. a yard for carriage, packing, etc., and paying a duty of 0·42 cents a metre; he sells half the cloth at 8 francs a metre, the rest at 6 francs a metre. What profit does he make?
(Express the result in pounds, shillings, and pence, and assume 25 francs equal to £1, and a metre to be $39\frac{3}{8}$ inches.)

4. Calculate the numerical value of $\dfrac{1}{\sqrt{8}}$ to seven places of decimals.

5. A bankrupt can pay 6s. 8d. in the £; if his assets were £500 more he could pay 7s. 4d. Find his debts and his assets.

6. The sum of the ages of A and B is now 60 years, and their ages ten years ago were as 5 to 3. Find their present ages.

Algebra.

1. Prove that the difference of the cubes of any two quantities divided by the difference of their squares equals the sum of the two quantities minus their product divided by their sum.
Point out the difference between the algebraical *proof* of this proposition and the arithmetical *illustration* afforded by the substitution of numbers for the two quantities.

2. Find the product of—
$$a^{\frac{3}{2}}-ab^{\frac{1}{2}}+a^{\frac{1}{2}}b-b^{\frac{3}{2}} \text{ and } a+a^{\frac{1}{2}}b^{\frac{1}{2}}+b;$$
and divide
$$6x^5+13x^4-14x^3-7x^2+18x-4 \text{ by } 3x^2+2x-4.$$

3. If a quantity is a factor of both a and b it is also a factor of $ma+nb$.
Find the G.C.M. of—
$$4x^3-27x^2+58x-39 \text{ and } x^3-8x^2+19x-12.$$

4. Simplify—
$$\left(\frac{3a^2-b^2}{4a^2-b^2}+\frac{2a-b}{2a+b}\right)\div\frac{a-\frac{4b}{7}}{2a+b}.$$

5. Find the square root of—
(*a*) $16x^6-24x^5+33x^4-50x^3+33x^2-24x+16$;
and prove that
(*b*) $\left(\frac{2a}{a-b}-1\right)^2+\left(1-b^2\right)\left\{\left(\frac{2}{a-b}\right)^2-1\right\}$
is a square.

6. Solve the equations—
(*a*) $\dfrac{a}{x-a}+\dfrac{b}{x-b}=\dfrac{a+b}{x-a-b}$.
(*b*) $\dfrac{1}{x^2-1}-\dfrac{1}{1-x}=\dfrac{7}{8}-\dfrac{1}{x+1}$.
(*c*) $\begin{cases}\dfrac{5x-8y}{21}-\dfrac{3x+2y}{28}=1.\\ x-\dfrac{5x-2y}{8}=4.\end{cases}$

7. Find the sum of n terms of an A.P. of which a is the first term and b the common difference.
Two clerks are engaged at the same time. A chooses a salary of £100 a year, increasing £20 annually. B chooses a salary of £50 per half-year, increasing £5 every half-year. Which makes the better bargain, and by how much in 20 years?

8. A number (n) is divided into three parts, such that one-third of the number exceeds the first part as much as the second part exceeds one-fourth of the number. Find the third part.

Geometry.

1. Prove I. 7. What use is made of Prop. 7? In the demonstration the contra positive of Prop. 5 occurs; where?

2. Prove I. 8. Find a point in a given line that shall be equally distant from two given points.

3. Prove I. 13. If one angle of a triangle be equal to the sum of the other two, the triangle can be divided into the sum of two isosceles triangles, and the base is equal to twice the line from its middle point to the opposite angle.

4. Prove II. 5. The difference of the sides of a triangle is less than the difference of the segments of the base made by the perpendicular from the vertex.

5. Prove III. 7. If through the point of contact of two touching circles any secant be drawn cutting the circles again in two points, the radii drawn to these points are parallel.

6. Prove III. 9. If two diameters of two touching circles be parallel, the lines from the point of contact to the extremities of one diameter pass through the extremities of the other.

SECOND YEAR—MEN.

Reading.
Penmanship.
Composition.
Geography.
History.
} As First Year.

Teaching.

Candidates should give at least one lesson per week, having previously prepared notes. If the lesson can be given under the criticism of an experienced teacher, so much the better; but if not, the practice is valuable, as it is much easier to write some sort of notes and not to keep to them in the lesson than to write good notes and keep to them, which is what is required by the Inspector.

School Management.

1. A boy comes to school for the first time on January 10th, and leaves the neighbourhood, without expectation of return, on March 10th. During these months he stays away on some days from illness, on others from truancy. On the 10th of May he returns with the expressed intention of remaining for another year at school, but he goes out to work for the three summer months. Then he becomes recognised as a half-timer, and continues alternately at work and at school, till he finally leaves on December 10th.
(*a*) Give all the entries that should be made for such a boy both in admission and class registers.
(*b*) Show how the average of a school, whose meetings were 400 in number, would be affected by 10 such boys attending for a period equivalent to twelve weeks each during the year.

2. What do you understand by a perfect definition, and what processes of thought are employed in arriving at one?

3. What do you understand by an 'excellent' school? (See Revised Instructions.)

4. Describe the best devices you know of (*a*) for ventilating, (*b*) for warming a school.

5. Define logic, term, syllogism.

6. What do you know of Locke's view of 'knowledge' and 'education'?

Music.

1. Write descending minor scales, *lah* mode: (*a*) once with the minor or flat seventh and the minor or essential sixth, and (*b*) once with the major seventh and the minor or essential sixth.

2. Write against each of the following intervals its name: *ma* to *de*^{1}, *fah* to *se*, *ta* to *soh*^{1}, and *fe* to *ma*^{1}.

3. What is the name for *ray* sharp, *te* flat, *soh* sharp?

4. Explain fully, as to a class, what is to be done in the following passage at $^d\mathbf{s}_1$.

Key C f F
s l r m ^{d}s$_1$ l$_1$ t$_1$ r d

5. Re-write the following in the first flat key:—
s ta l m s f de r m ta l s f

6. Write the pulse signs and time names for four-pulse, six-pulse, and nine-pulse measures.

English.

Gray.—As First Year.

Richard II.

1. Scan Act I., Scene i. 23; Scene II. 7.

2. Parse: object (I. i. 28), pilch (109), recreant (144), which (173), his (194), may (Scene II. 42), right (I. i. 46), do you and myself (I. i. 186), sceptre's (I. i. 118).

3. Comment on I. i. 80–81, inherit (85), partialize (120), there is no boot (164), line 168, Lord Marshal (204), caitiff (Scene II. 53), Plasby (66), for these eighteen years, leopards.

4. Write the ten lines commencing 'Each substance of a grief hath twenty shadows.' What historical inaccuracies occur in the play?

Comment upon lists, height, cousin, baffled, rancour, verge, coward, pawn. (*N.B.*—Mark the etymology of these words.)

Tempest.

1. By whom and in what connection occur the words—'O, the cry did knock against my very heart!'

2. Scan the lines—

'The sky, it seems, would pour down stinking pitch.'
'His tears run down his beard like winter's drops.'
'I do not think thou canst, for then thou wast not.'

3. Comment upon line 46, Scene I., merely (52), this rascal (53), line 25, lines 26–32, lines 100–3; 'the title of the play was likely to be attractive to an audience in the time of James I.'; 'to trash for overtopping.'

4. Give an account of the source and early editions of the play.
What is a Masque?
Write a summary of Scene I. Act i.

Macbeth.

1. Who was the speaker, and what is the context of—

'The earth hath bubbles as the water hath'?

2. What was the condition of Scotland in the time of Duncan?

3. Why is this not a historical play?

4. What is an Alexandrine? Quote examples from the play.

5. Write a summary of Act I. Scene ii.

Geometry.

1–6. As First Year.

7. Prove IV. 3. The square described about a circle is twice the inscribed square.

8. Prove VI. 2. If two triangles have a common base, but different vertices, they are to one another as the segments into which the line joining the vertices is divided by the common base or base produced.

Algebra.

Questions 1–8. As First Year.

1. Prove that $\log \frac{a^m}{b^n} = m \log a - n \log b$.

Given log. 7 = ·845 and 980, log. 252 = 2·4014005, find log of 49, ·36, and $(252)^{\frac{1}{5}}$. Of how many digits will the last named quantity be composed?

2. Find the amount of a given sum in n years at r per cent. compound interest. Find also the present value of a sum due after n years at r per cent., compound interest.

3. Find the number of combinations of n things, taken r together. How many triangles can be formed by joining the corners of a pentagon in every possible way?

4. Assuming that the coefficient of x_q^{r-1} in the continued product of the $(n-1)$ factors $(x-a_1)(x-a_2) \ldots (x-a_{n-1})$ is the sum of the products of the $(n-1)$ letters, $a \ldots a_{n-1}$, taken $(r-1)$ together, prove by the introduction of another factor that the law holds for the coefficient of x in the continued product of (n) such factors. Write down the middle term of $\left(x+\frac{1}{x}\right)^{2n}$.

5. (*a*) $\sqrt{x+10} + \sqrt{x-10} = \frac{60}{\sqrt{x+10}}$.

(*b*) $x^2+y^2-xy(x+y+2)+x^2y^2 = 31\ x+y+xy = 11$.

(*c*) Prove that a quadratic equation has two roots and no more.

If the ratio of the roots of $x^2+px+q=0$ be equal to that of the roots of $x^2+rx+s=0$ then will $p^2 : r^2 :: q : s$.

6. A man who walks up hill at the rate of $2\frac{1}{2}$ miles an hour, and down hill at the rate of 5 miles an hour, ascends and descends a hill in 6 hours, how many miles did he walk, and what was the height of the hill, the rise being 1 in 8?

FIRST YEAR—WOMEN.

Reading.
Penmanship.
School Management.
Composition.
Music.
English.
History.
Geography.
} As First Year Men.

Needlework.

1. Cut out and tack together one leg of a child's pair of drawers, and on the calico supplied, show the stitches required in making up the garment.

2. Write notes of a lesson on stroking and setting-in.

Domestic Economy.

1. Name the chief considerations under the heads Foundation, Site, Light, and Drainage, which ought to be kept in view in building a house.

2. Give, naming the exact proportions, the constituents of atmospheric air, and explain the separate use of each of them.

3. What is the difference between arterial and venous blood? Explain why the circulation of the blood is needed to maintain the health of the body, and by what habits or acts such circulation is promoted or hindered.

4. Classify the several kinds of vegetable substances used as food. Take any three of such substances, describe their composition and the way in which they serve to nourish the body.

5. What are 'condiments'? Name four of those in most general use. Say whence they are obtained and what purpose they serve.

6. Give a list of all the articles which should be found in a well-furnished laundry, and name the prices of the various substances to be used in washing. Mention also some precautions which are needed in the use of any of these substances.

Arithmetic.

1. Find the profit on 1,000 tons of meat bought at £70 per ton, and retailed at 5s. 10d. per stone of 8 lbs., after paying 30s. per ton for carriage.

2. A schoolmaster divided his scholars, consisting of 221 boys and 143 girls, into the largest possible equal classes, so that each class of boys should number the same as each class of girls. Find the number of classes.

3. Reduce $\frac{8}{17}$ to a fraction having unity for its numerator, $3\frac{1}{3}$ to a fraction having $\frac{4}{7}$ for its numerator, and $\frac{8}{9}$ to a fraction having 100 for its denominator.

4. A room 16ft. wide cost £14 8s. to carpet at 4s. 6d. per yard, find the length of the room, the width of the pieces of carpet being 18 inches.

5. A tradesman's prices are 20 per cent. above cost price, if he allows a customer 10 per cent. on his bill, what profit does he make?

6. On the 1st of January, 1870, a contractor borrows a sum of money at 5 per cent. simple interest. At the end of a year the rate of interest is reduced to $4\frac{1}{2}$ per cent. The total amount of interest paid up to the end of 1875 is £1,760; what was the sum borrowed?

SECOND YEAR—WOMEN.

Reading.
Penmanship.
School Management.
Teaching.
Composition.
Music.
English.
History.
Geography.
} As Second Year Men.

Needlework.

1. Draw a diagram of a boy's shirt showing the various parts of the garment, and give directions for making it up.

2. Make and stitch a band of calico.

3. Write notes of a lesson on feather-stitching.

Domestic Economy.

1. By what methods and appliances may good ventilation be secured?

2. What differences should be made in stewing meat for eating and for soup? Give reasons.

3. Explain the working and respective advantages of benefit clubs, annuities, life assurance, and cooperative societies.

4. What is the normal temperature of the body, and how can it be kept uniform?

5. If you give four hours per week to needlework, how would you allot them, and why?

6. In a family of four, having an income of twenty-eight shillings per week, how could the wages be most wisely distributed?

NOTES ON THE OCTOBER QUESTIONS—MEN.

Penmanship.

Whatever style of writing is adopted, the formation of the letters should be the same in the *two* lines required. The capital letters are marked highly.

Composition.

The first subject is from Ruskin, and gives good scope for descriptive science.

The other subjects are stock, and require care only in method of arrangement.

School Management.

1. See par. 65, Cartwright's M.S., and page 135. To which might be added that the arrangement of the T. T. should show that the teacher can use his theoretical knowledge to obtain voluntary attention by utilising the laws of association in the lessons which precede and follow any given lesson.

2. The cause is largely want of practice to a given end. The remedy is plenty of exercise in accurate measurement, drawing to scale and to estimated form, matching colours, and in the higher standards writing descriptions of events quickly passing, such as a simple experiment, a song, shop window, etc.

3. Cartwright, Chap. VI.

4 ,, pars. 44–46, pars. 226–233.

5. There are many differences of opinion on 1–3, but roughly the schedules of the Code give a fairly good answer.

For 4, music, drawing, and drill are the chief factors.

6. Cartwright, page 137.

7. The greatest mistake is in forgetting the law of contrast, and giving the dates too close together.

It is important that the well-defined epochs should be clear in the child's mind, and for that purpose dates are useful. For example, the Conquest, Reformation, Commonwealth, and Revolution ought to be well-known.

English.

1. *Disclose* Verb, agreeing with 'hours.'
reclined Descriptive of verb, agreeing with 'me' (16).
vain - Adj., used substantively, agrees with 'ardours.'
youth - Col. noun, hence 'are.'

2. *that* - Rel. pro., subject to 'blow.'
reclined Participle.
still - Adv. (gazed).
she - Per. pro., subject to 'had gazed.'
cat's - 'Cat is,' interrogative form.

3. *Hills* - Nominative of address.
stranger Appositional description (childhood).
yet - Adv. (to pain) is simplest form, but some would make it adjective (stranger).

The analysis is all straightforward.

4. In commenting note :—

(1) That the allusions must be cleared up.

(2) Definitive etymologies should be given, not mere curious speculations.

(3) The use should be clearly explained.

6. The analysis in the Introduction forms a good basis, but it is too bald for an account. Students should master it, and then write in the form of an essay, taking care to note in the text exactly where each point of the analysis receives illustration.

Arithmetic.

1. $814 = 4 + 10 + 800$

$4327 \times 4 = 17308$
$4327 \times 10 = 43270$
$4327 \times 800 = 3461600$
$4327 \times 814 = 3522178$

$121711 = 11 + 700 + (11 \times 11000)$.
$32856 \times 11 = 361416$. (*a*)
$361416 \times 11000 = 3,975,576,000$. (*b*)
$32856 \times 700 = 22,999,200$. (*c*)
Add *a*, *b*, *c*, for answer.

2. Similar method giving 5,724,096,747,950,354,972.

3. $364 = 2^2 \times 7 \times 13$
$2520 = 2^3 \times 3^2 \times 5 \times 7$
$5445 = 3^2 \times 5 \times 11$.

4. A takes 10 m. to go round.
B ,, 6 ,, ,,
C ,, 5 ,, ,,
∴ time together at starting place is the L.C.M. of the separate times, viz., 30 m.
C goes twice as fast as A, the three are only abreast at the starting point.

5. Similar question. Ans. 2 hrs from starting.

6. Half-sovereign is 240 half-pence.
£3 17s. $10\frac{1}{2}$d. is 1,869 ,,
L.C.M. is 149,520 ,,
1 oz. is 1,869 ,,
∴ $\frac{149,520}{1,869}$, or 80 ozs., is the Answer.

Algebra.

See Horobin's Solutions (Gill and Sons) for full solutions.

1. 127.

2. (*a*) Take the 1 over to the right hand and work with that side as the difference of two squares.

(*b*) $x^2 - (m+n)x + mn$.

3. $4x^2 - 9x + 6$.

5. $x^2 - ax + a^2$.

6. $x = 7$; $x = 9\frac{1}{17}$ or -11.

7. 13, 10, 7, etc.

8. $x = 10\frac{10}{11}$ min.

Euclid.

1. Use I. 47.

2. Let bisectors be AB, CD, the intersection being E; then if F be any point in ED, joining AF, BF, we have AE = BE, EF common, and ∠AEF equal ∠BEF.
∴ AF = BF.

3. Let ABCD be the lozenge, having AD, BC, for diagonals.
Then AB = BC.
∠ACB = ∠ABC,
and DB = DC.
∴ ∠DCB = ∠DBC.
∴ ∠ACD = ∠ABD.
∴ by I. 4, ∠CAD = ∠BAD,
and ∠CDA = ∠BDA.
∴ AD is an axis of symmetry.

4. Let ABC be the right-angled △.
In base AB cut off AD = AC, and BE = BC.
Then $AB^2 = AC^2 + CB^2 = AD^2 + BE^2$.
But $AD^2 = AE^2 + ED^2 + 2AE.ED$. (1)
$BE^2 = BD^2 + ED^2 + 2DB.DE$. (2)
∴ AB^2 = (1) + (2).
Also $AB^2 = AE^2 + ED^2 + DB^2 + 2AE.ED + 2ED.DB + 2AE.DB$.
∴ $ED^2 = 2AE.DB$.

5. Let AB be the given line, and C the given point.
If any point D be the centre of a circle passing through C, and CF be a ⊥r from C on AB cutting the circle again in F, then all circles having AB as the line of centres pass through C.
Take any point G in AB, and describe circle having GC as radius. Join FG.
EC = EF, and EG is common, and ∠CEG = ∠FEG.
∴ CG = FG.

6. Draw a figure, and it is plain the two circles have—
(*a*) Equal radii.
(*b*) The same centre.
∴ they are congruent.

WOMEN.

Arithmetic.

1. 3, and 1875 remainder. Notice the divisor is $5^4 \times 3 \times 5$, and by dividing in this order finding the remainder is very easy.

2. Loss on one rupee is $2\frac{3}{4}$d.

∴ salary in rupees is $\frac{£145\ 5s.\ 10d.}{2\frac{3}{4}}$, or 12,680 rupees.

3. $4,081 = 7 \times 11 \times 53$.
$7,007 = 7^2 \times 11 \times 13$.
$7,392 = 7 \times 11 \times 2^5 \times 3$.
∴ H.C.F. is 7×11, or 77.

4. Express all sums in sixpences, and find L.C.M. This gives 840 sixpences, or $\frac{840}{40}$ pounds.

5. Part lost is $\frac{1}{2} \times \frac{4}{5-2} = \frac{2}{3}$.
∴ he has remaining $\frac{1}{3}$, which is £3,500.
∴ he lost £7,000.

6. C's share is £2,750, and B's $\frac{7}{25}$ C.
∴ B's share is £8,470.
And A's share is $\frac{9}{55}$ B, or £770.
And D's share is $\frac{1}{11}$ C, or £2,500.

Domestic Economy.

1. Pages 158–162, 448. (Hughes's 'Domestic Economy.')

2. Page 460, No. 7. (Hughes's 'Domestic Economy.')

3. Pages 287, 242. (Hughes's 'Domestic Economy.')

4. Pages 100, 233, 330, 452. (Hughes's 'Domestic Economy.')

5. In both cases the all-important thing is to remember that there must be a free passage of air; and, secondly, that the fuel must be so disposed as to readily ignite from the paper and wood used in the lower layers.

6. It would be unfair to advertisers to choose a particular machine for description, but we may mention, as amongst the simpler forms, Summerscales' Household Washer, the Canadian Prize, and Bradford's Patent Vowel Machine.

School Management.

1. The only part of the question which is catchy is the second question about the 'too late' children.
The best and simplest form is a 'too late' register. This enables at once a comparison of 'present' and 'marked' if inquiry be made at a visit without notice, and ensures a record which might be useful in attendance cases.

2, 3, 4. All answered fully in 'Cartwright.'

5. Etymology can only be used effectively in an upper class, and that only where there has been previous drilling in word-building, and a good knowledge of the ordinary affixes and prefixes. Good examples can be chosen from the English books.

English.

All the questions are straightforward, and can be answered directly from the syllabus work.

Algebra.

For full solution, see Horobin's 'Certificate Tests' (Gill and Sons).

1–8. As First Year.

9. If x, y, z, be the quantities, and e the log base,

$$x = e^a,$$
$$y = e^b,$$
$$z = e^c.$$

Where a, b, c, are in A.P.

$$\therefore a - b = b - c,$$
$$\text{or} \quad \frac{e^a}{e^b} = \frac{e^b}{e^c}, \text{ etc.}$$
$$108 = 2^2 \times 3^3, \text{ etc.}$$
$$\cdot00142 = \frac{128}{90000} = \frac{2^7}{3^2 \times 10^4}, \text{ etc.}$$

10. Take population to start with as unity,

$$\text{then } \log A = \log P + 10 \log (1{\cdot}04)$$
$$= 10 \log (1{\cdot}04)$$
$$= {\cdot}17033$$
$$= \log 1.48;$$

that is, proportionate addition is 48 per cent.

11. $$n(n-1)(n-2) = 56n,$$
$$\text{or } n^2 - 3n - 54 = 0.$$
$$(n-9)(n+6) = 0.$$
$$\therefore n = 9, \text{ or } 10,$$

value being inadmissible.

12. Ordinary bookwork :—

(*a*) $1 - nx + \frac{n(n-1)}{2}x^2 -$.

(*b*) $\frac{n(n-1)\ldots(n-r+1)}{\underline{|r}}$.

13. (*a*) Multiplying, squaring, and collecting—

$$4x^2 - x(17a - 9b) + (13a^2 - 9ab) = 0,$$
$$\text{whence } x = \frac{(17a - 9b) \pm (9a - 9b)}{8}.$$

(*b*) The second equation is

$$x(x^2 + y^2) + y(x^2 + y^2) = 888,$$

whence substituting in (1)

$$x + y = 12.$$

Square this, and subtract first equation, and

$$2xy = 70,$$
$$\text{or } (x - y)^2 = 4.$$
$$\therefore x = 7, \text{ or } 5.$$
$$y = 5, \text{ or } 7.$$

(*c*) The common root is a line or factor of both equations, ∴ it measures their difference, viz. :

$$-16x^2 + 4x + 240,$$
$$\text{or } -4(4x + 15)(x - 4).$$

Of these $(x - 4)$ is the only common factor.
$\therefore x = 4$ is the required root.

14. Let x be first year saving.

Then £26 5s. 5d. $= x + \frac{3x}{2} + \left(\frac{3}{2}\right)^2 x +$ to 8 terms.

Bring to pence and sum series :

$$x = 10s.\ 8d.$$

Euclid.

1–6. As First Year.

7. Draw figure, and mark the angles, then one of the triangles, as BFC, where C is centre, and F middle point of a side, gives at once :

$$r^2 = \left(\frac{a}{2}\right)^2 + \left(\frac{r}{2}\right)^2 \text{ etc.}$$

8. Let the lines be AE, BF, and the parallels AB, CD, EF.
Join BE, cutting CD in G.
In △ AEB, AC : CE :: BG : GE.
In △ BEF, BG : GE :: BD : DF; hence, etc.

Arithmetic.

1. $3\frac{1}{3}$ acres = 16,940 square yards.
22 yards = 100 links.
∴ 22^2 square yards = 100^2 square links, etc.
350,000 square links.

3. Multiplying each fraction by 40, giving
420, 275, 196.
L.C.M. of these is 161,700.
∴ L.C.M. of fractions is $\frac{161,700}{40}$, or $4,042\frac{1}{2}$.

7. $$5a^2 - 13ab - 52b^2.$$
$$x^5 + 2x^4 + x^3 - 4x^2 + 11x + 10.$$

Multiplying by 12 :

$$3(x + 6) - (16 - 3x) - 2.25 = 0,$$
$$\text{or } 6x + 2 - 50 = 0,$$
$$\text{or } x = 8.$$

Domestic Economy.

All the questions are straightforward, and fully answered in Hughes's 'Domestic Economy.'

MENTAL ARITHMETIC FOR THE STANDARDS.

BY T. B. ELLERY, F.R.G.S.,
President of the National Union of Teachers.

'Mental work will strengthen the power of computation, and facilitate the handling of simple problems.'—MR. CODD, H.M.I.S.

Fifth Paper.

STANDARD II.

IN our last paper we reached the number 100, dealing with the pence and shillings tables up to that point. The slate or paper work of Standard II. (Arithmetic) will suggest to us the course of 'Mental' which must be followed. It will not be necessary, of course, to employ large numbers or large sums of money in the exercises set. What we want is regular daily practice in counting, in the tables, and in making simple calculations in money so as to ensure readiness. In some schools simple weights and measures are introduced, such as the pound, half-pound, quarter-pound, the ounce, and half-ounce, the quart, the pint, and half-pint, the yard, foot, and inch. This practice might well form a 'Suitable Occupation,' and in my opinion it is one of the best yet suggested. Without going into details just now, what could be better—if we must have 'Suitable Occupations'—than letting the little ones 'keep shop'? They might 'buy' and 'sell' a yard, or half-yard of cloth or anything else at hand, a pound of salt, half pound of sugar, a pint or half pint of milk, etc., etc. Money should be employed, and the little ones taught to give change when 'purchases' are made. It is, I repeat, a particularly useful 'occupation,' and one which will certainly interest the children. But I must not continue the subject at this stage, though we may, perhaps, adopt the idea in some measure as we proceed with these lessons. Let us look at the arithmetic requirements for Standard II.

Scheme A.—'Notation and numeration up to 100,000. The four simple rules to Short Division. The multiplication table and the pence table to 12*s*.' The mental exercises, therefore, should be preparatory to slate or paper work up to that point, though it will be advisable to give practice in simple calculations involving the sovereign, £2, £3, etc. I shall try to show that this is possible without attempting anything beyond the capacities of the children in this standard. For example: John earns 10*s*. and his brother a sovereign. How much do they earn together? How much is this less than £2? What must you add to £2 to make £4? £5? etc. What is the half of a sovereign? the fourth of a sovereign? the fifth of a sovereign? A man buys goods to the value of 16*s*., what change from a sovereign? What must you add to £2 10*s*. to make £3? The teacher can lead up to this by easy stages, and our Standard I. course will have paved the way. But let us go back to the tables and numbers to 1000. We have reached 100. Let the children see the relative value of each figure. 1 *hundred*, no *tens*, no *units*. Take 110. 1 *hundred*, 1 *ten*, no *units*. Let the children see that the first 1 (one hundred) is ten times the second 1 (one ten). Then take 111 (one hundred, one ten, and one unit). The first 1 (one hundred) is ten times the second 1 (one ten) and one hundred times the third 1 (one unit). Write several numbers (in hundreds) on the board, and call upon the children to name the relative values of the figures employed. This practice is too frequently neglected, with the result that the children are not as familiar with the building up of numbers as they ought to be. Then proceed to 200, 300, 400, and so on up to 1,000. Take the numbers, 222, 333, 444, as illustrations, and arrange them on the board in this way:—

222	333	444
200	300	400
20	30	40
2	3	4
222	333	444

Then how many twenties in two hundred? How many twos in twenty? in two hundred? How many thirties in three hundred? How many threes in thirty? in three hundred? How many forties in four hundred? How many fours in forty? in four hundred? And so on.

After the children have been practised in this and similar calculations, this may be given. The half of 100 is 50. What is the half of 200? 400? 600? 800? What is the half of 300 (that is 200 + 100)? The half of 500 (that is 400 + 100)? What must you add to 50 to make 100? What must you add to 150 to make 200? to make 300? to make 400? Add the half of 200 to the half of 400. Take 200 from 600 and from your answer take 300. What is the half of 1,000? What must you add to 700 to make 1,000? What is the tenth part of a thousand? the fifth part? What is the half of 500? And then, what is the fourth of a thousand? Add 200, 300, 400, and 50. What must you add to your answer to make 1,000? And so on.

Our tables must receive careful attention. We have reached 6 times 12 = 72, and we have now to go on to 12 × 12 = 144. I again suggest that the multiplication tables and the pence tables should be taught at one and the same time. It will save time in the end. The 7 times table might be taught and repeated thus:—

	s.	d.
7 times 1 is 7		
7 „ 2 „ 14	1	2
7 „ 3 „ 21	1	9
7 „ 4 „ 28	2	4
7 „ 5 „ 35	2	11
7 „ 6 „ 42	3	6

As in Standard I., the tables should be built up carefully. Let the children, for example, see seven pennies arranged in each of three rows. They will see for themselves that 7 times 3 is 21. They know (from our previous practice) that there are 12 pence in a shilling, and that 12 from 21 is 9. Hence, 21 pence = 1*s*. 9*d*. So with 7 times 4 is 28, 2*s*. 4*d*.; 7 times 5 is 35, 2*s*. 11*d*. There must then be constant repetition, and, if home lessons are given, the tables should be copied on slate or paper by the children and taken home. In time, when a boy repeats 7 times 5 is 35, he is also ready with the pence portion (2*s*. 11*d*.). In my own teaching throughout the school I have found this of very great service. Having tried the plan for many years I

know it is possible to carry it out, and that it is 'worth the doing.' At the same time, the shillings table will receive careful attention, of course. We have reached 72 pence = 6s., 84 pence = 7s., 96 pence = 8s.

Proceeding on the same lines, we have 108 pence = 9s., 120 pence = 10s., 132 pence = 11s., and 144 pence = 12s.

As the multiplication tables are built up and committed to memory on the lines I have suggested this will come easily enough.

The *sixpences* will also be known. For example, 7 times 6 is 42, 3s. 6d.; $\left\{\begin{matrix}9 \text{ times } 6\\6 \quad \text{,,} \quad 9\end{matrix}\right\}$ is 54, 4s. 6d.; 6 times 11, or 11 times 6, is 66, 5s. 6d.; 9 times 10, or 10 times 9, is 90, 7s. 6d.

The use of actual coins will make these tables something more than a mere repetition, dry, uninteresting, and tedious. The mental practice, based on the portions known, will also assist in 'fixing' the tables and in making them understood. In time, such exercises as these will be readily worked.

A man spends 6d. on each of 9 days. How much less than 5s. does he spend?

I had ten shillings (half a sovereign) in my purse. I gave 6d. to each of 8 boys and 4 girls. How much had I then?

A man bought a book for 5s. 6d., and a hat for 4s. 6d. What change from half-a-sovereign? from 12s.?

A man had eleven shillings. He spent 4s., then 3s. 6d., and then 2s. 6d. How much had he then? And so on.

In conclusion I submit a number of exercises, each of which will suggest to the thoughtful teacher many similar ones.

1. How many sixpences in 6s.? In 7s.? In 7s. 6d.? In 10s.?

2. How many threepences in 2s.? In 4s.? In 5s.? In 10s.?

3. How many threepences in half-a-crown (2s. + 6d.)? In a crown?

4. How many sixpences must you add to 4s. 6d. to make 6s.? To 7s. 6d. to make 10s.? To 8s. 6d. to make 12s.?

5. How many half-crowns in 5s.? In 7s. 6d.? In 10s.?

6. How many half-crowns in 12s. 6d.? In 15s.? In 17s. 6d.? In £1? In £2? In £5?

7. What must you add to 5 half-crowns to make 15s.? To make £1?

8. By how much does 7 half-crowns exceed 14s.?

9. A man bought 6 books at half-a-crown each, and another at 1s. What did he spend in all?

10. Seven nines? Eight nines? Nine elevens? Ten twelves?

11. 120 pence? 107 pence? 99 pence? 131 pence? 121 pence?

12. What must you add to 9 times 9 to made 90? To make 100?

13. What must you add to five dozen to make 100? To make 200? To make 400?

14. A woman earns 6d. a day for three weeks (18 days). How much does she earn in all? How much is this less than a sovereign?

15. What is a florin? What must you add to 4 florins to make 10s.? To make 12s.? To make £1?

16. By how much does 4 half-crowns exceed 3 florins?

17. Take 7 sixpences from 5s.; from 10s.; from £1.

18. What must I add to

s.	d.	
9	6	
5	6	
13	6	to make £1?
16	6	

19. Take 7 nines from 8 tens.

20. How many half-dozens are in 84? In 96? In 108?

21. A woman bought a hat for 3s. 6½d. What change from 5s.? (4s. + 1s.)

22. Take 2s. 6½d. from 5s.; 1s. 11½d. from 3s.; 5s. 1d. from 7s.

23. How many *dozens* are there in 84? In 120? In 132?

24. How many *scores* in 80? In 100? In 120? In 200?

25. I spent 2s. 4½d., and then a shilling. How much is this less than two florins?

26. What is the half of 1,000? The fourth of 1,000? The fifth of 1,000?

27. What must you add to the half of 1,000 to make 600? To the fourth of 1,000 to make 300?

28. Add the half of 500 to the fourth of 800.

29. What is the third of 600? Add the third of 600 to the half of 400.

30. How many *dozens* are there in six *score*?

31. Add 3 nines and 4 tens.

32. Take the tenth part of 100 from the half of two dozen.

33. If you spent 1s. 8½d., and then 2s. 1d., how much have you spent in all? How much is this less than 4s?

34. Add 200, 150, and 250.

35. Add 60, 140, and 300, and divide your answer by 5.

36. How many times is 6 contained in 7 twelves? 8 in 4 tens? 4 in 12 nines? 5 in 10 tens?

37. What must you add to the difference between 250 and 280 to make a hundred?

38. What must you add to 11 elevens to make 130? 140? 144?

39. What must you add to 8 elevens to make 10 tens?

40. How many tens are there in the sum of 150, 40, 110?

41. What is the difference between 8 times 18 and 10 times 18? (= twice 18.)

42. I buy 50 buns at a penny each, and 20 at a halfpenny each. What do I spend in all?

43. If pears are sold at 6d. a dozen, how many can I buy with 8d.?

44. How many farthings must you add to 2s. 2½d. to make half-a-crown?

45. A man sold 16 penny newspapers and 16 halfpenny papers. How much did he receive?

46. I bought 20 apples, and divided each into quarters. To how many boys could I give five quarters?

47. Add 3s. 8½d. to the half of 4s. 6d.

48. How many halfpence in the sum of 7d., 8½d., and 3d.?

49. I divide 120 apples equally among 5 men, 4 women, and 3 boys. How many apples did the 3 boys receive together?

50. There are ten baskets on the table. In each of 6 of them there are ten pears, and in each of the others 5 pears. How many pears altogether?

51. Find the total cost of a pound of butter at 1s. 3d. a pound, two pounds of sugar at 3d. a pound, and half a pound of tea at 2s. a pound.

52. If tea is sold at half-a-crown a pound, what would you pay for 8 ounces? For 4 ounces? (There are 16 ounces in a pound.)

53. There are two pints in a quart. If a quart of milk cost 4d., what will you pay for three pints?

54. A yard of cloth costs 2s. 5d. What will you pay for 3 yards?

55. What shall I pay for three pounds of sugar at 3d. a pound, and 8 ounces of tea at 1s. 6d. a pound?

56. There are 16 ounces in a pound. How many ounces in 2½ pounds?

57. If you pay 8s. for 4 pounds of tea, what will you pay for 5 pounds?

58. There are 12 inches in a foot. How many inches altogether in 6 feet and 6 half feet?

59. Find the cost of half a pound of tea at 2½d. an ounce. What change from 2s.?

60. I bought 3 pounds of tea at 1s. 6d. a pound, and 4 pounds of sugar at 3d. a pound. What change from half a sovereign?

CONVERSATIONAL LESSONS IN CHEMISTRY.

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For particulars of the List of Chemicals and PRACTICAL TEACHER Set of Apparatus for working the experiments referred to in these lessons see numbers for January and February 1893.

LESSON XXVII.—VINEGAR.

When we wish to say that a thing is very sour, what words do we generally use, Charlie? Look on the table if you do not quite see what I mean. We say 'As sour as vinegar,' sir. Exactly; and vinegar is the subject of our present lesson. You already know much about this interesting substance, and we cannot do better than begin by seeing what our knowledge really amounts to. You, Tom, shall commence. It is an acid, sir. That is hardly correct, and yet not incorrect, as I will explain. Vinegar is really a mixture of many different substances, the most important of which is an acid, called acetic acid, of which here is a specimen. Only from three to five per cent. of vinegar is acetic acid, the rest being water, alcohol, and various other acids. You see now why I call Tom's answer neither right nor wrong. Why was Tom so positive that vinegar was an acid, Trixie? Because it is sour, sir. Yes, and something else. Go on, Harry. Because it turns the blue pickle-cabbage red. Quite so; and now we will perform two other experiments in confirmation of this same view. Here is some washing soda, which, as you all know, is soda carbonate. Pour on it some of the vinegar, Ernie. See how briskly the mixture effervesces. Pass some of the escaping gas into lime water, and then tell me what you observe. The lime water becomes milky, sir, therefore the escaping gas is carbon dioxide. That is quite correct, and vinegar, like other acids, thus decomposes carbonates.

Next fit up a flask with thistle-funnel and leading tube, having first placed some zinc in the flask. Pour in some vinegar. Test the escaping gas with a flame. It burns, for it is hydrogen. We can then have no further doubt as to the acidity of vinegar.

Vinegar has long been a familiar household commodity. It was well known to the ancients, who made it from wine. It is also manufactured from beer, so that the substance from which vinegar is made must be contained in both beer and wine. What is that substance, Maud? It is alcohol, sir. Yes; you no doubt have recollected that both wine and beer are alcoholic drinks. In fact, it is the contained alcohol that gives them their power to intoxicate the immoderate drinker.

Nothing can be more interesting than the way in which alcohol is transformed into vinegar. Sour beer or wine is trickled down an oaken tower over beech shavings in order to expose a large surface of the liquid to the action of the oxygen of the air, for all that has to be done to the alcohol to transform it into vinegar is to oxidise it.

You will, perhaps, remember that iron does not combine directly with the oxygen of the air, but only with oxygen that has been dissolved by water, wherefore iron only rusts in moist air.

This will help you to remember that alcohol cannot take oxygen directly from the atmosphere, but requires an intermediary between it and the air. But the agent is much more wonderful, in the case of alcohol, than in that of iron, for here the oxygen is brought into combination by the agency of a minute vegetable organism, known, for this reason, as mother of vinegar, or *mycoderma aceti*, which in some way, not altogether understood, transfers oxygen from the air to the alcohol, and so forms acetic acid, the time occupied in the quickest method of formation being only about 26 hours. Now, Charlie, you shall perform an experiment for me. Take this long test tube and place therein this little strip of wood. Now hold the tube horizontally, and apply heat to the end in which the wood lies. Tell me what you observe. The wood has turned to charcoal, sir. Yes; it is in this way that charcoal is prepared, viz., by heating wood in a limited supply of air, so that it cannot burn, but is compelled to give off its volatile constituents. Such a process is known as destructive or dry distillation, and a still such as we used in the preparation of nitric acid is the apparatus usually employed in the operation. But once more let us turn to our tube, and notice that in the cool and upper portion we have a brownish oily liquid, and in addition a clear watery fluid. Place a strip of blue litmus paper in the watery liquid, Lilla, and tell us what you learn from your experiment. The paper turns a bright red, sir, proving that the watery liquid is an acid. Right; and the acid is no other than acetic acid, for which reason acetic acid is known sometimes as 'wood vinegar.'

Now let us turn to acetic acid once more. Notice its strong, sharp odour. It is a very powerful acid. Here is a portion that I have cooled down somewhat, but not to a very low

temperature. See, it has frozen or crystallized, which it does at about 15°C., or at the ordinary temperature of the air. To do this, however, it must be pure. Well, Joe, what is it? Do we not distil coal that makes coal-gas just in the same way that you did the wood just now? Yes; and the brown oily liquid got from wood is like the tar obtained from the distillation of coal, the chief difference being that whereas the watery liquid obtained from wood is acid, from the presence chiefly of the acid of vinegar, the watery liquid obtained in the case of coal is alkaline, from the presence of ammonia. We must now bring our lesson to a close by once again remarking that vinegar is an aqueous solution of acetic acid, containing in addition various colouring and flavouring substances.

NOTES AND NOTIONS.

BY RICHARD WADDINGTON.

I WENT to the meeting of the Educational Institute of Scotland last month, full of the intent to view the Scotchman on his native heath. One hears so much and sees so little of 'the way they do it in Scotland,' that I confess I was more than anxious to meet my colleagues across the border in Conference assembled. My experiences were of the happiest. Through these columns I had made many warm-hearted friends, and, as a part of the deputation from the N.U.T., I everywhere received the kindliest hospitality and the utmost good fellowship. What could be done to render the stay in Edinboro' pleasant and enjoyable was done, even to the abandonment of the usual uneventful course of the Conference itself, which brought to mind the Conferences of the N.U.T. discussing Electoral Districts, Age and Attendance, and other equally contentious subjects. There was a spirit of discontent abroad that grew in volume as the morning session advanced. 'The old order changeth' was the opinion of the representatives as they left the High School on the Saturday afternoon.

* * * * *

As I entered the Conference room with Mr. Macnamara, Mr. Kerr was fitly closing his presidential term by voicing the wrongs of teachers and taught in his presidential address. In our Union the maiden effort of the president of the N.U.T. is the address, while in Scotland the closing act of the president is the delivery of his valedictory address. In language as choice as incisive, Mr. Kerr laid bare the wrongs of primary education 'across the border.' The defects are very nearly the defects of our English schools, save that they are not so aggravated. One hears little of the Voluntary Problem. Fortunately the primary schools of Scotland have not been largely the battle ground of religious strife. But Mr. Kerr had an eloquent appeal for the rural schools and the teachers of small schools, with an incisive demand for the reasonable security of tenure of the teachers in the interest of the taught. The large assembly punctuated the protests and condemnations with incisive applause, which burst forth anew as Mr. Kerr resumed his seat and made ready to instal his successor.

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MR. DUNLOP, of Brogue, having been nominated by the General Committee, is proscribed the precincts of the Conference until led forth by the two Vice-presidents to be invested by the retiring president with the gold chain.

> 'His locked, lettered, braw brass collar
> Shewed him the gentleman and scholar.'

Mr. Dunlop soon discovered that he had taken the helm in anything but a dead calm. Glasgow was strongly against the Government—in fact the feeling set strong against the powers that be. The constitution of the Institute was only saved from the melting pot by the production of the Charter at times of emergency in the well of the Hall, wherein sat 'the Guv'r'ment." But the cry for reform was strong and loud, and despite the Charter and the glorious past, the Committee found things anything but easy to manage. Mr. Dunlop must have craved for a bell or a hammer. Amendments, questions, and points of order were propounded in bewildering confusion. The meeting grew unruly, but Mr. Dunlop, cool and collected, applied the closure on his own initiative, and saved the Conference by giving the members time to cool during the taking of the vote.

* * * * *

MY impressions of the Educational Institute were pleasing ones. The signs of vitality were strong during the discussions. The reformers were able and earnest. 'Though they may gang a kennin' wrang,' they are intent on the good of all, and there is much scope for action. To attempt to stifle or restrain it would be a serious menace to real unionism. The Institute, if it would fulfil its mission, must democratise. The arrangements of the Conference hardly seem to secure that it shall be a conference of chosen representatives. The method of voting by show of hands alone strikes me as being a few years behind the times. And 'trust your Executive Committee' is a dictum that goes a long way in England, but hardly so far as in Scotland. The Balance Sheet shows that the Scotch teacher requires to dip deeper if he means the organisation to be more effective. The total expenditure for the year is only just over £500, an altogether insignificant sum to urge the numerous demands enumerated in the presidential address. The Press hardly fully appreciates the doings of the Institute if I am to judge by the notices devoted thereto.

* * * * *

ON the adoption of a Scheme of Benevolence on the lines of our Benevolent and Orphan Funds, I heartily congratulate the Institute. And here they set us an admirable example by adding the cost to the subscription of the Institute, and not leaving it to the generosity of the members. If we could adopt this course in England we should save much anxiety as to the Easter effort, and do much to make the Associated Teacher alive to the duty of taking a keen interest in the funds. Some day, perhaps, we shall follow in the wake of Scotland in this matter.

* * * * *

THE keen interest of the younger men in the Institute is a hopeful augury of the future. There are sure to be many who feel 'Gar's auld claes look amaist as weel's the new.' But I am sure the far-seeing leaders of the Scottish Teachers will feel

that the Institute must rise to modern demands by devolving as much of the responsibility as possible on the individual. To one and all of my friends in Scotland I would say, 'Mend, but don't end, your valuable organisation.'

* * * * *

But before I leave the land of Burns, there is one point of pressing interest to English Teachers. The Executive Committee of the Institute is elected on what we call the Electoral Districts plan. District representation is now being strongly advocated in England, and it is, therefore, interesting to see how it works in Scotland. The representative must reside in the district, with the result that, in several districts, there are more than sufficient men who ought to go before the constituents, if judged by their ability to represent the teachers, but they won't oppose one another. Hence all that local union enthusiasm that is to accrue from the local contest only exists on paper. Able men remain outside because they won't oppose the man in possession, and without this condition, the theory of District representation breaks down. As organising bodies, District Unions are necessary and useful; but it does not, therefore, follow that the ideal form of representation is to be obtained through the District Union member. The present arrangement for electing the Executive may not be the best possible, but I am not sure that Electoral Districts would mend matters.

* * * * *

The new form of Inspecting is producing some amusing incidents. One Inspector has reported that he found the teacher sharpening lead pencils while giving the Scripture lesson. In another school the Assistant Master saw a stranger perambulating the passage outside the class-room. Going out to inquire, the following took place:—

Teacher: 'Well, what do you want?'
Inspector: 'Don't you know who I am?'
Teacher: 'No; but if you don't get out quick you'll know who I am.'
Inspector: 'But I am Mr. ——, H.M.I.'

And then the laugh came, and the teacher felt that the Education Department ought to have a uniform dress for its officials, or send round their photographs.

Inspecting another school, the Inspector came to a teacher giving an Object Lesson, when he, turning to the Head Teacher, said:—

'What lesson is this?'
Reply: 'An Object Lesson.'
'What! an Object Lesson without the object.'
Reply: 'Yes; it is on the horse.'
And the Inspector began to discuss Word-building and the teaching of Spelling.

* * * * *

Mr. Athelstan Riley is doing more harm to genuine religious teaching than can be fully appreciated, and more to encourage cant and hypocrisy than all the Bishops of the Church can undo. Badgered by Mr. Macnamara, in a moment of honest lucidity he announced, 'The 3,000 teachers alluded to have been grossly insubordinate to the Board, who pay their salaries. They have treated the Board with contempt, and he will never consent to place in the Board Schools a teacher who has been insubordinate, and who leaves them in the dark as to whether he is a Christian man or not.' Can bigoted intolerance go further? Because, forsooth, these teachers refuse to parade their religious beliefs at the will of Mr. Riley, and notwithstanding the pledge given that they should suffer no professional disability by accepting the offer made in the Circular by claiming exemption, they are to be branded as atheists and unbelievers. Surely there is not another member of the Board that in his heart condones such injustice. As a member of the Church of England, and a teacher in a Church School, I can only regret my inability to express fully my disgust and contempt for men of the fibre of Mr. Riley.

* * * * *

It is surprising to note the prominence given by the advocates of increased aid to Voluntary Schools to the abolition of the seventeen and sixpenny limit. The extent of the relief afforded by the withdrawal of the limit will be seen from the following table taken from the current Blue Book:—

——	Amount per scholar deducted under Article 107.
Church of England Schools	3¼d.
Wesleyan Schools	3¼d.
Roman Catholic Schools	3¼d.
British Undenominational Schools	2¾d.
Board Schools	1½d.
Voluntary Schools	3¼d.
Board Schools	1½d.

The amount is so small, that it is hardly worth the notice it receives; and it is worthy of note that the Boards that suffer under this article are not amongst those that deal most liberally with the teachers. It is not difficult to see that the withdrawal of the limit would not tend to increase the voluntary contributions.

* * * * *

Take the case of some of the School Boards that suffer under Article 107. In every case the amount spent on the teachers is lamentably below the general average. The average amount spent on salaries per scholar in average attendance in Board Schools was £1 17s. 9¼d., and in:—

School Board.	Expenditure per scholar in average attendance for salaries.	Amount deducted per scholar under Article 107.
Birkenhead	£1 12s. 9d.	11¼d.
Hull	£1 10s. 2¼d.	1s. 8¾d.
Manchester	£1 17s. 7¾d.	1¼d.
Oldham	£1 15s. 6½d.	1¾d.
Portsmouth	£1 5s. 9¾d.	9½d.
Salford	£1 15s. 2½d.	1d.
Sunderland	£1 11s. 6½d.	5¾d.

Now take Portsmouth, where the amount taken from the rates for all purposes amounts to 5s. 3¼d.

per scholar, and where the amount spent on salaries stands 12s. below the average for the Board Schools of the country. If the limit were abolished, the Board would be able to take off ninepence from the five shillings and threepence at present contributed by the ratepayers.

* * * * *

But the Portsmouth Board would, without doubt, go further. The grant per head reaches 15s. 11d. in Portsmouth against an average of 19s. 3½d. for the Board Schools of the country. Assured that they could get the 19s. 3½d. without increasing the rate, the Portsmouth School Board would see that for twelve shillings per head less the teachers earned the full grant, and thus there would be no need to levy a rate at all in Portsmouth. And Portsmouth would not stand alone. Can you imagine the small School Board desirous of keeping down the rates under such conditions? Why, the teacher would have to box the compass from Schedule 1 to Schedule 4 until the rate had disappeared. There are cases of hardship under the limit of Article 107, but they are insignificant when placed side by side with the protection afforded to both teachers and taught. Teachers want to walk charily towards the abolition of the limit. The relief afforded will be too slight to be felt unless it is followed by a large extension of the curriculum, which means harass, worry, and over-pressure for teachers and taught.

* * * * *

The appointment of Messrs. Davidson and Worley is a concrete illustration of the disability under which the practical expert labours in attaining the rank of Her Majesty's Inspector of Schools. By avoiding the Primary School, and paying a dutiful homage at the University shrine, Mr. Davidson attains the rank of Inspector of Schools at twenty-seven. Mr. Worley passes through the Primary Schools and the Training College and takes twice the time to reach the same position. The factory operatives have made this impossible in the case of Inspectors of Factories, and it is time we teachers bent our energies fully to the task. The 'prentice hand has wrought too much mischief on the lives and professional careers of the teachers in the past, and it is high time that the first qualification for an Inspector of Primary Schools should be at least a ten years' training within the four walls of the class of school the inspector will be called upon to assess and inspect. Mr. Davidson may be all that a man could be under the circumstances, but he can have but a nodding acquaintance with the work of our Primary Schools.

* * * * *

The new Drawing Regulations are on the lines of South Kensington—the old distrust of the teacher, and the same old absurd regulations as to the holding of the paper, etc. The children must not turn the paper in executing the copies. Why not? In every-day life there is perfect freedom. This is one of the senseless irritating facts that one expects only from South Kensington. But the most dangerous part of the regulations relates to the desire expressed to increase the difficulty of the second standard requirements. And one cannot help feeling that this is partly due to the too-oft expressed ability of some teachers to do more. Too often a few Oliver Twists, crying for more, bring increased work for all. My experience is that the work requires considerable reduction, especially in the upper standards. Henceforth the papers worked are to be retained for at least two months. What next? Teachers are to store reams of used paper to satisfy the Department that Drawing is taught. Are we ever going to get the slightest evidence of sympathy from South Kensington?

* * * * *

And then there is the syllabus for small schools. This is the most practical sign of recognition of the needs of the primary schools that has come from the department of Science and Art. The scheme is not an ideal one, but it is an attempt to solve a difficult problem. Too much is attempted, especially in the second stage, where the Model Drawing might be eliminated with advantage. The scheme ought to be available for schools of less than 150 in average attendance. For in such schools it rarely happens where the schools are mixed that there is more than one teacher for the Drawing. Why is the fixed examination to be perpetuated in Drawing? Surely the position is anomalous. The only subject in which I am face to face with the Annual Exhibition Day is Drawing. The State can so far trust the teachers here to do the best for the children without the turmoil of a fixed examination when £800 of grant depends upon the result, but the Science and Art Department must have a fixed examination, schedules, and all the other paraphernalia before we can receive the modest and altogether inadequate £20 which they contribute.

* * * * *

Mr. Acland is indisposed and goes for a long holiday. The strain of the last few years has told upon the late Vice-President. He worked hard for teachers. His sole object was the good of education. Often I thought him misguided, but I always felt his sincerity. I hope the holiday may be pleasant and recuperative both for himself and Mrs. Acland.

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'True Unionist' will note that I have touched upon the point he mentions. Need I assure him that I quite agree with all he says, and can only wonder at our better-circumstanced colleagues 'giving the case away.'

* * * * *

'Rural'—Many thanks for your kind references to my efforts to get the Drawing Syllabus made reasonable, and Object Lessons and Suitable Occupations made optional. With regard to the Occupations I don't believe in their necessity, and, if I did, I maintain the accomplishment is impossible under present conditions.

* * * * *

'Syntax' complains of the invidious distinction drawn by the present mode of exempting schools from the annual examination. I quite agree, and hope the Department will give the new arrangement a fair chance by exempting all schools.

QUERY COLUMN.

Amateur.—Two towns are connected by three lines of railway, A, B, and C. Route B is 4·71 miles an hour faster than A and slower than C; A is 23½ miles longer than C, and takes twice the time; B is three miles shorter than C, but takes 5 minutes longer. What are their lengths?

Let x = rate of A in miles per hour;

then $x + 4{\cdot}71 =$,, B ,, ,,

and $x + 9{\cdot}42 =$,, C ,, ,,

Let y = time in hours to do the journey by C;

then $2y =$,, ,, ,, A;

and $y + \frac{1}{12} =$,, ,, ,, B.

Then distance by A $= 2xy$;

by B $= (y + \frac{1}{12})(x + 4{\cdot}71)$;

and by C $= y(x + 9{\cdot}42)$.

Then $2xy - 23\frac{1}{2} = y(x + 9{\cdot}42)$; (A)

and $(y + \frac{1}{12})(x + 4{\cdot}71) + 3 = y(x + 9{\cdot}42)$. (B)

By (B)

$$xy + 4{\cdot}71y + \tfrac{1}{12}x + {\cdot}3925 + 3 = xy + 9{\cdot}42y;$$

$$\therefore \tfrac{1}{12}x = 4{\cdot}71y - 3{\cdot}3925.$$

Multiply all terms by 1200,

$$\therefore 100x = 5652y - 4071. \quad \text{(C)}$$

By (A) $2xy - 23\frac{1}{2} = xy + 9{\cdot}42y$;

$$\therefore xy = 23\tfrac{1}{2} + 9{\cdot}42y.$$

Multiply all terms by 100,

$$\therefore 100xy = 2350 + 942y.$$

Substitute the value for $100x$ found by (C),

then $y(5652y - 4071) = 2350 + 942y$.

$$\therefore 5652y^2 - 5013y = 2350.$$

Divide all terms by 5652,

$$\therefore y^2 - \tfrac{557}{628}y = \tfrac{1175}{2826}.$$

Add square of $\frac{557}{1256}$ to each side,

$$\therefore y^2 - \frac{557}{628}y + \left(\frac{557}{1256}\right)^2 = \frac{310249}{(1256)^2} + \frac{1175}{2826}$$

$$= \frac{2792241 + 5903200}{(3768)^2}$$

$$= \frac{8695441}{(3768)^2}.$$

Extract square root,

$$\therefore y - \tfrac{557}{1256} = \tfrac{2948}{3768} \text{ approximately};$$

$$\therefore y = \tfrac{4630}{3768} = \tfrac{385}{314} \text{ hrs.} = 1{\cdot}23 \text{ hrs. approximately};$$

$$x = \frac{5652y - 4071}{100} = \frac{6930 - 4071}{100} = 28{\cdot}59 \text{ miles per hour.}$$

Distance by A $= 2xy = 2 \times 28{\cdot}59 \times 1{\cdot}23 = 70{\cdot}33$ miles approximately.

Distance by B $= (y + \frac{1}{12})(x + 4{\cdot}71) = 43{\cdot}73$ miles approximately.

Distance by C $= y(x + 9{\cdot}42) = 46{\cdot}75$ miles approximately.

Puzzled.—An ironmonger marked his goods 40 per cent. above cost price, but by an accident interchanged the figures in the shillings in the price of a fender, and so lost 2s. 6d. What should the article have been marked?

It is evident that the figures in the shillings were only two, as the term 'interchange' can only properly be applied to two things. Moreover, three or more figures can be changed in position in such a variety of ways as to render it impossible to give any definite solution to the question if three or more figures in the shillings are considered to be admissible.

Granted that the number of shillings is less than 100, the question can be solved experimentally.

It must first be noticed that the difference in price occasioned by the interchange of figures is some multiple of nine shillings. Thus 73s. 4d. *minus* 37s. 4d. = 36s.; 85s. 6d. *minus* 58s. 6d. = 27s., etc.

Now, as the difference in price causes not only a loss of all the profit of 40 per cent., but a loss of 2s. 6d. besides, it follows that 40 per cent. of cost price + 2s. 6d. = some multiple of 9s.

∴ Some multiple of 9s. — 2s. 6d. = 40 per cent. of cost price.

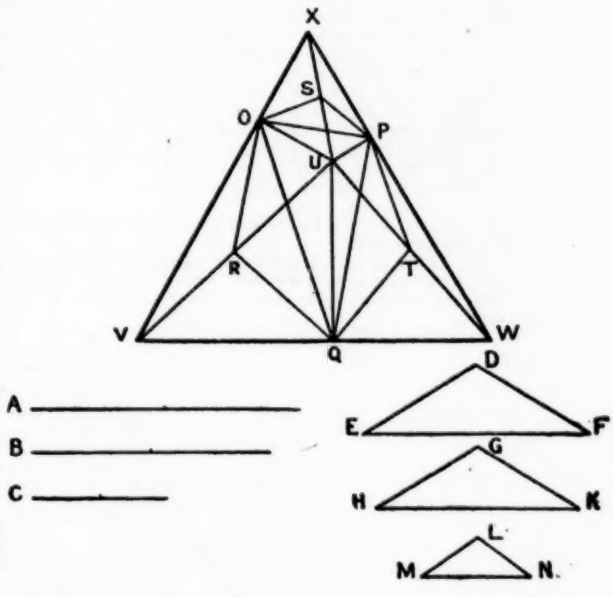
Since the article is marked at 140 per cent. of the cost price, and $140 = 40 \times 3\frac{1}{2}$, it follows that (some multiple of 9s. — 2s. 6d.) × 3½ = price the article should have been marked.

If now we experiment by subtracting 2s. 6d. from successive multiples of 9s., multiplying this result by 3½, and noting the difference in price caused by the interchange of figures, we shall find only one case in which this difference equals the multiple of 9s. we commenced with.

Multiples of 9s.	40 per cent. cost price.	140 per cent. cost price.	Difference caused by interchange.
9s. 0d.	6s. 6d.	22s. 9d.	Nil.
18s. 0d.	15s. 6d.	54s. 3d.	9s.
27s. 0d.	24s. 6d.	85s. 9d.	27s.

It is evident that the article should have been marked 85s. 9d. Assuming a gain of 40 per cent. on the cost price, the cost price of the article would have been 61s. 3d. By marking the article at 58s. 9d., 2s. 6d. is lost.

Hopeful, Dumfries.—To construct an equilateral triangle, having given three lines severally equal to the distances from its angular points to a point within it.



Let A, B, C be the three given straight lines. Bisect each of them. Make isosceles triangle DEF, having each of its equal sides DE, DF equal to half A, and the angle EDF equal to double the angle of an equilateral triangle. Make two other similar isosceles triangles, GHK, LMN, having their equal sides respectively equal to half B and half C, and their angles at the apex equal to double the angle of an equilateral triangle. Construct a triangle OPQ, having OQ = EF, PQ = HK, and OP = MN. On the side of OQ remote from P, and with OQ as base, construct an isosceles triangle OQR, having each of the equal sides = ½ A. On PQ as base, in a similar manner construct an isosceles triangle PQT, having each of the equal sides = ½ B. From R as centre, with ½ A as radius, draw a circle; and from T as centre, with ½ B as radius, draw a circle cutting the former circle in U. Join UR, UT, and produce UR to V, making RV = ½ A, and UT to W, making TW = ½ B. Join VQ, QW. Then VQW is a straight line. Join UQ. In the triangle VQU, VR, RU, and RQ are each equal by construction to ½ A. They are, therefore, equal to each other. Hence the angle RQU = angle RUQ, and angle RQV = angle RVQ. Therefore angle RQU + angle RQV, or whole angle VQU = angle RUQ + angle RVQ. Hence (I. 32) VQU is a right angle. Similarly it may be proved that WQU is a right angle. Therefore VQW is a straight line.

Join VO, WP and produce these lines to meet in X. Then VWX is the equilateral triangle required. We first prove that it is an equilateral triangle.

Since VRO, RQV are each isosceles triangles, angle RVO = angle ROV, and angle RVQ = RQV. Then (I. 32) angle ORU = twice angle RVO, and angle URQ = twice angle RVQ, or the whole angle ORQ = twice angle OVQ. But the triangle OQR = triangle DEF, and the angle ORQ = angle EDF, which was made equal to twice the angle of an equilateral triangle. Therefore angle ORQ is double the angle of an equilateral triangle. Therefore the angle OVQ = the angle of of an equilateral triangle. Similarly it may be shown that the angle PWQ = the angle of an equilateral triangle. Then the remaining angle VXW = the angle of an equilateral triangle.[4]

And the lines UV, UW, drawn from the point U within it to the angular points V and W, are respectively equal to A and B. Join U, X. We have now to prove that UX = C.

Join UO, UP. The angles VOU, WPU can be proved right angles by employing a similar method of proof to that used in proving that UQV and UQW were right angles. Then UOX and UPX are right angles. Bisect UX in S, and join SO, SP.

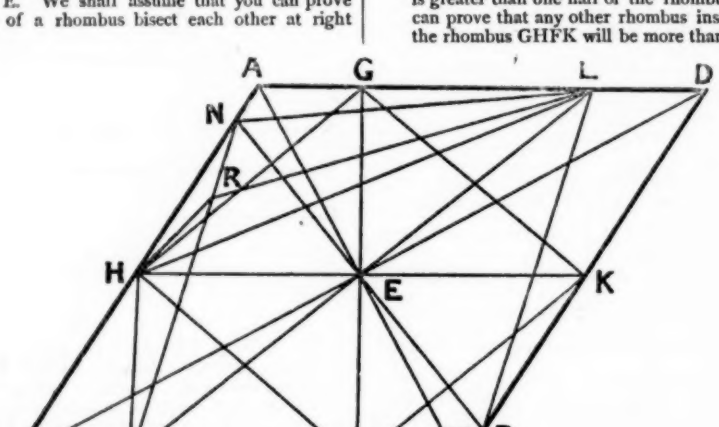
Then SO = SU or SX. For, if it does not equal either of these, it must be greater or less than either of them. If greater, angle OXS is greater than angle SOX, and angle OUS is greater than angle SOU, or the whole angle UOX is less than the sum of the angles OUS and OXS. But by I. 32 angle UOX = angle OXU + angle OUX. Then SO is not greater than SU or SX. Similarly we can prove it to be not less. Then SO = SX or SU. Similarly we can prove SP to be equal to SU or SX. Then SO = SP (Ax. 1), and the triangles OSP, OSX, PSX are isosceles triangles. Then the angle OSP can be proved double of the angle OXP in a similar way to that in which ORQ was proved double of OVQ. Then the angle OSP is double of the angle of an equilateral triangle. Therefore it is equal to the angle MLN. Then each of the angles SOP, SPO is equal to either of the angles LMN or LNM. And the base OP was made equal to the base MN. Then OS or SP = LM = ½ C. Then SU = ½ C, and UX = C.

J. S. (*Glasgow*).—Show how to inscribe the least possible rhombus in a given rhombus.

Let ABCD be the given rhombus. Draw the diagonals AC, BD, intersecting at E. We shall assume that you can prove that the diagonals of a rhombus bisect each other at right angles.

From E draw EF perpendicular to BC, and produce FE to meet AD in G. Then by I. 29 it can be proved that FG is at right angles to AD, and by taking the equal triangles AEG, EFC, EG can be proved = EF. Through E draw HEK parallel to AD or BC. By taking the equal triangles HEB, EDK, HE is proved equal to EK. Join HG, GK, KF, FH. By I. 47 these lines can be proved all equal, and it can easily be proved that the quadrilateral formed is equiangular with the original figure ABCD. HGFK is therefore a rhombus, and it is the least possible rhombus which can be inscribed in the given rhombus. The parallel HK divides the rhombus ABCD into two equal portions, AHKD and HBCK. It also divides the inscribed rhombus into two equal portions, GHK and HFK (I. 34). But since the parallelogram AHKD and the triangle GHK are on the same base HK, and between the same parallels HK, AD the parallelogram is double of the triangle (I. 41). Similarly, the parallelogram HBCK is double of the triangle HFK, and the rhombus ABCD is therefore double of the inscribed rhombus GHFK. We have now to prove that any other rhombus inscribed in ABCD will be more than one half of ABCD.

Through E draw LEM, terminated by AD and BC and not parallel to AB or CD. By the equal triangles GEL and EFM, EL may be proved equal to EM. By using equal triangles the figure ABML may be proved equal to LMCD. ABML therefore = one half of ABCD. Through E draw NEP at right angles to LEM, and terminated by AB and CD. By equal triangles, EN may be proved = EP. Join NL, LP, PM, and MN. Then NLPM is a rhombus, of which NML is the half. Join HM and HL. Then the triangle HME = triangle HEB (I. 35), and the triangle HEL = triangle HEA (I. 35). That is, the whole triangle MHL = the whole triangle AEB. But the triangle AEB is one quarter of the rhombus ABCD. Then the triangle HML is one quarter of the rhombus ABCD. From H draw HR parallel to ML, meeting MN in R, and join RL. Then the triangle MRL = the triangle HML (I. 35). Then the triangle NML, which is one half of the rhombus NLPM, is greater than the triangle HML by the triangle NRL. But the triangle HML has been proved equal to one quarter of the rhombus ABCD. Then one half of the inscribed rhombus NLPM is greater than one quarter of the rhombus ABCD. That is, the whole of the inscribed rhombus NLPM is greater than one half of the rhombus ABCD. Similarly we can prove that any other rhombus inscribed in ABCD except the rhombus GHFK will be more than one-half of ABCD.



LEGAL AND CODE QUERIES COLUMN.

RULES.

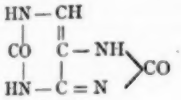
1. All communications must be addressed 'Legal Editor, PRACTICAL TEACHER, Froebel House, St. Andrew's Hill, Doctors' Commons', E.C.,' and must be accompanied by our 'coupon,' duly filled up.
2. Replies will be given *only* in this column, except under the conditions named in Rule 3.
3. If any reader desires a reply by post, such can be forwarded by enclosing, in addition to the coupon, a stamped addressed envelope and either stamps or a Postal Order to the value of one shilling.
4. No original documents should be forwarded, but copies only. We cannot hold ourselves responsible for any losses which occur through non-observance of this rule.

Our Science Section.

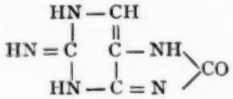
ORGANIC CHEMISTRY NOTES.

BY J. T. HEWITT, M.A., D.SC., PH.D.,
Professor of Chemistry, People's Palace Technical Schools.

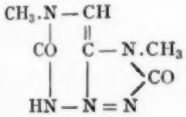
SOMEWHAT nearly related to uric acid in constitution are the compounds guanine and xanthine, and the di- and tri- methyl derivatives of the latter, theobromine and caffeïne. The composition and constitution of these substances is expressed by the following formulæ :—



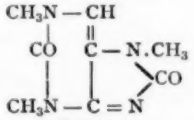
Xanthine.



Guanine.



Theobromine.



Caffeïne.

Guanine, $C_5H_5N_5O$, occurs in guano (hence its name), the excrement of spiders, and in the pancreas of the horse ; it is deposited also in the knee-joints of swine suffering from guanine gout. The base can be prepared from Peruvian guano by boiling with milk of lime, separating the solid matter containing uric acid and guanine from the brown solution. The residue is then repeatedly extracted with boiling sodium carbonate solution ; to the solution, sodium acetate is first added, and then hydrochloric acid, until the reaction is strongly acid ; on cooling, the hydrochlorate of guanine crystallises out. As this, however, is still contaminated with uric acid, the latter must be removed by boiling with dilute ammonia, the guanine dissolved in hot nitric acid, when, on cooling, the nitrate crystallises ; from this the free base can be obtained by ammonia.

Guanine is a strong diacid base ; the hydrochlorate, chlorplatinate, sulphate and nitrate have been prepared. It also dissolves in caustic soda ; from this solution, alcohol separates the compound $C_5H_5N_5O$, $(NaOH)_2 + 5H_2O$. Strecker found that the solution of guanine in hot baryta-water deposits needles on cooling, which after drying over sulphuric acid have the composition $C_5H_3BaN_5O$.

Guanine is oxidized by heating with potassium chlorate and hydrochloric acid to parabanic acid, carbon dioxide, and guanidine, $C(NH)(NH_2)_2$.

When guanine is treated with nitrous acid, xanthine is produced according to the equation

$$C_5H_5N_5O + HNO_2 = C_5H_4N_4O_2 + N_2 + H_2O.$$

Hence guanine must be xanthine in which an oxygen atom is replaced by an imido-group.

Xanthine, $C_5H_4N_4O_2$, is a constituent of the animal body, having been found in muscle, liver, pancreas, spleen, and brain. It is a granular white powder of crystalline structure, very sparingly soluble in water, insoluble in alcohol, more easily soluble than uric acid in ammonia, still more readily soluble in potash. It is a weak acid and weak base ; boiling with baryta water gives a difficultly soluble compound, $C_5H_2BaN_4O_2.2H_2O$; the sulphate, $C_5H_4N_4O_2.H_2SO_4 + H_2O$, loses the whole of its acid when washed with water. Formerly it was supposed that uric acid could be reduced to xanthine by sodium amalgam ; this was disproved by Fischer.

Theobromine, $C_7H_8N_4O_2$ or $C_5H_2(CH_3)_2N_4O_2$, can be obtained from powdered cocoa-beans by boiling with water, precipitating the solution with lead acetate, removing the excess of lead by hydrogen sulphide, and evaporating the residual solution to dryness. This is then recrystallised from alcohol and purified by another recrystallisation or sublimation. Emil Fischer obtained theobromine from xanthine by dissolving the latter in two molecules of caustic soda ; the boiling solution gave a precipitate of lead xanthine, $C_5H_2PbN_4O_2$, with lead acetate ; this, heated with methyl iodide to 100°, gave dimethylxanthine or theobromine. Theobromine forms microscopic crystals of bitter taste, slightly soluble in water; it gives unstable salts with acids; by ammonia and silver nitrate, silver theobromine, $C_5HAg(CH_3)_2N_4O_2$, is produced, which, on heating with methyl iodide gives trimethylxanthine or caffeïne. When oxidised with aqueous chlorine, methyl urea and methyl alloxan are produced.

$$C_5H_2(CH_3)_2N_4O_2 + H_2O + O_2 = C_4O_4N_2H(CH_3) + CO\begin{matrix}NH_2\\NH.CH_3\end{matrix}$$

Oxidation with hydrochloric acid and potassium chlorate gives dimethyl-alloxantin, $C_8H_4(CH_3)_2N_4O_8 + 4H_2O$.

Caffeïne or theïne, $C_8H_{10}N_4O_2$, was prepared in the pure state from coffee in 1821 independently by Runge, Pelletier and Caventon, and Robiquet. Oudry discovered theïne in tea in 1827; the identity of the two substances was proved by Jobst and Mulder. Caffeïne is obtained from tea dust by a method analogous to that given for the preparation of theobromine from cocoa beans. It is a very weak base, reaction neutral; the salts are decomposed by water. The hydrochlorate has the formula $C_8H_{10}N_4O_2.HCl + 2H_2O$, the chlorplatinate is $(C_8H_{10}N_4O_2.HCl)_2PtCl_4$, the chloraurate is $C_8H_{10}N_4O_2.HAuCl_4$, the sulphate $C_8H_{10}N_4O_2.H_2SO_4$, and the acetate $C_8H_{10}N_4O_2.(C_2H_4O_2)_2$. The so called *citrate of caffeïne* of commerce is the base itself.

The constitution of caffeïne was worked out by Emil Fischer (*Ber.* 14. 637 and 15. 30). Stenhouse, by treating caffeïne with nitric acid, got cholesterophane, $C_5H_6N_2O_3$. Rochleder, by the action of chlorine and water, amalic acid, $C_{12}H_{12}N_4O_7$. Strecker proved these compounds to be dimethylparabanic acid and tetramethylalloxantin respectively ; he also showed that caffeïne heated with baryta-water gives carbon dioxide and caffeïdine, $C_7H_{12}N_4O$.

The latter is hydrolysed by alkalies to ammonia, sarcosine, methylamine, formic acid, and carbon dioxide.

$$C_7H_{12}N_4O + 5H_2O = NH_3 + 2CH_3.NH_2 + CH_3.NH.CH_2.COOH + H.COOH + CO_2.$$

Fischer confirmed these results and also found that by oxidation monomethyl-urea and dimethyl-alloxan can be produced from caffeïne ; hence caffeïne contains three methyl groups.

Bromine gives with caffeïne, monobromcaffeïne, $C_8H_9BrN_4O_2$, the latter with alcoholic potash, $C_8H_9(OC_2H_5)N_4O_2$, whilst hydrolysis of this ethoxycaffeïne with hydrochloric acid yields hydroxycaffeïne, $C_8H_9(OH)N_4O_2$. This substance will take up a molecule of bromine (proof of double linkage); the dibrom addition product reacts with acoholic potash as follows :—

$$C_8H_9(OH)N_4O_2Br_2 + 2KOC_2H_5 = C_8H_{10}N_4O_3(OC_2H_5)_2 + 2KBr.$$

This diethoxyhydroxycaffeïne splits in two ways on heating with hydrochloric acid, furnishing apocaffeïne, $C_7H_7N_3O_5$, or hypocaffeïne, $C_6H_7N_3O_3$.

$$C_8H_{10}N_4O_3(OC_2H_5)_2 + 2H_2O = C_7H_7N_3O_5 + 2C_2H_5OH + CH_3.NH_2 ;$$

or

$$C_8H_{10}N_4O_3(OC_2H_5)_2 + 2H_2O = C_6H_7N_3O_3 + CO_2 + 2C_2H_5OH + CH_3.NH_2.$$

When apocaffeïne is boiled for some time with water, caffuric acid is formed.

$$C_7H_7N_3O_5 + H_2O = CO_2 + C_6H_9N_3O_4.$$

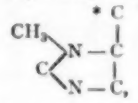
This latter substance may be hydrolysed (by heating with lead acetate) to mesoxalic acid, methylamine, and methylurea.

$$C_6H_9N_3O_4 + 3H_2O = C(OH)_2(COOH)_2 + CH_3.NH_2 + CO_2\begin{matrix}NH.CH_3\\NH_2\end{matrix}$$

Hydriodic acid, however, reduces it to hydrocaffuric acid, $C_6H_9N_3O_3$; this when hydrolysed by baryta water gives carbon dioxide, methylamine, and methylhydantoïn.

$$C_6H_9N_2O_3 + H_2O = CO_2 + CH_3.NH_2 + CO\begin{matrix}N(CH_3)-CH_2\\NH-CO\end{matrix}$$

Hence hydrocaffuric acid probably contains the atom grouping



the carbon atom marked * being that which appears as carbon dioxide. The same grouping must also hold for caffuric acid, apocaffeine and caffeine itself.

Hypocaffeine, the other product obtained by the action of hydrochloric acid on diethoxyhydroxycaffeine, breaks up on heating with baryta water into carbon dioxide and caffolin.

$$C_6H_7N_3O_3 + H_2O = CO_2 + C_5H_9N_3O_2.$$

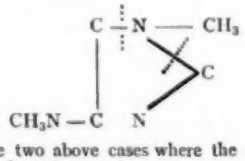
Caffolin can be oxidised either to methyloxamic acid and methylurea (by potassium ferricyanide),

$$C_5H_9N_3O_2 + O + H_2O = CH_3.NH.CO.COOH + CO\begin{matrix}NHCH_3\\NH_2,\end{matrix}$$

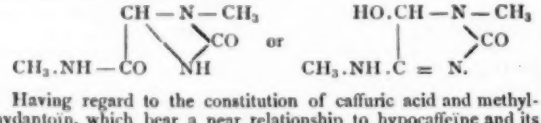
or to dimethyloxamide, carbon dioxide, and ammonia (by potassium permanganate).

$$C_5H_9N_3O_2 + O + H_2O = \begin{matrix}CO-NH-CH_3\\CO-NH-CH_3\end{matrix} + CO_2 + NH_3$$

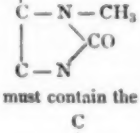
Therefore caffolin contains a nucleus,



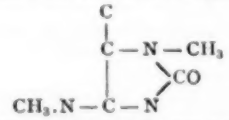
which splits up in the two above cases where the dotted lines are shown, and hence its formula must be :



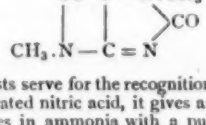
Having regard to the constitution of caffuric acid and methylhydantoïn, which bear a near relationship to hypocaffeine and its derivatives, the latter of the two formulæ must be correct. From this and the fact that caffuric acid and apocaffeine contain the group



we now see that caffeine must contain the complex



We still have to insert another carbon atom, a nitrogen atom, and a methyl group, and having regard to the production of dimethylalloxan and methylurea by the oxidation of caffeïne, the $C_8H_{10}N_4O_2$ molecule must have the constitution



The following tests serve for the recognition of caffeïne :—Evaporated with concentrated nitric acid, it gives a yellow fleck of amalic acid, which dissolves in ammonia with a purple colour. (An analogue of muroxide is thus produced.) Evaporated with chlorine water, caffeïne yields a purple red residue ; this turns a golden yellow on strongly heating, but the red colour reappears again with ammonia.

Sarcine, or hypoxanthine, $C_5H_4N_4O$, occurs in the spleen, the muscles, etc., also in the blood after death ; it is not found in flowing blood. It is found in extract of meat to the extent of ·6 per cent. ; this substance is the best source from which to obtain it. The extract is dissolved in water, and precipitated by acetate of lead. The filtrate is then freed from lead by hydrogen sulphide, concentrated by evaporation, ammonia added, and then silver nitrate to precipitate sarcine silver nitrate, $C_5H_4N_4O.AgNO_3$. This characteristic salt is first washed with dilute ammonia, and then recrystallised from the least possible quantity of nitric acid of specific gravity 1·1. The crystals, which separate after standing some time, are separated from the liquid (from which xanthine-silver-oxide can be precipitated by addition of ammonia), treated with an ammoniacal silver solution, and finally decomposed by hydrogen sulphide.

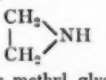
Sarcine dissolves in 300 parts of cold, or 78 parts of boiling water ; it is a crystalline powder. Like the other compounds described above, it behaves as weak base and weak acid. Oxidation with fuming nitric acid leads to the formation of xanthine and also of a nitro compound.

Adenine, $C_5H_5N_5$, is a base which results from the breaking down of nuclein. Just as guanine gives xanthine by treatment with nitrous acid, so does adenine yield sarcine.

$$C_5H_5N_5 + HNO_2 = C_5H_4N_4O + N_2 + H_2O.$$

There are a few naturally occurring bases which belong to the fatty series and are not built up of six-membered rings.

Spermine, C_2H_5N, occurs in semen and the heart and liver of the calf. It crystallises in radiating masses, is easily soluble in water, nearly insoluble in absolute alcohol, reacts strongly alkaline, and attracts carbon dioxide and moisture from the atmosphere. Very possibly it is ethylene-imine,



Sarcosine, $C_3H_7NO_2$, or methyl glycocoll, is a decomposition product of creatine, which occurs in muscular tissue. Since Volhard obtained it by the action of ethyl chloracetate on methylamine, it must be regarded as methyl glycocoll.

$$Cl.CH_2.COOH + CH_3.NH_2 = HCl + CH_3.NH.CH_2.COOH$$

$$\left(\text{or } \begin{matrix}CH_2-NH_2.CH_3\\CO-O\end{matrix}\right)$$

Choline, or bilineurine, $C_5H_{15}NO_2$, is found in the bile of the ox and pig, and is a decomposition product of lecithin, which occurs in the yolk of egg. It was synthetically prepared by Wurtz, who allowed a concentrated solution of trimethylamine to stand with ethylene oxide for a whole day ; from this, and the fact that the substance behaves as an ammonium base (splitting of water when salts are formed), we arrive at the constitutional formula

$$\begin{matrix}CH_2\\|\\CH_2\end{matrix}\!\!>O + H_2O + N(CH_3)_3 = N(C_2H_4OH)\,(CH_3)_3OH$$

Lecithin (*i.e.* the distearyllecithin) has the probable constitution,

$$C_3H_5\begin{cases}(OC_{18}H_{35}O)_2\\OPO\begin{cases}OH\\OC_2H_4N(CH_3)_3OH,\end{cases}\end{cases}$$

since it breaks up on hydrolysis into glycerophosphoric acid, choline, and stearic acid. Other lecithins are known, from which palmitic and oleïc acids have been obtained in place of stearic acid.

Neurine, $C_5H_{13}NO$, a base nearly related to choline, is a decomposition product of protagon, a complicated compound which is a constituent of the brain. The free base, which is known in aqueous solution and its salts, is vinyltrimethylammonium hydroxide, proved by its formation from choline in the following manner :—When choline is acted on by hydriodic acid, both hydroxyl groups are replaced by iodine, and the iodethyltrimethylammonium iodide, $C_2H_4I.N(CH_3)_3I$, so formed, gives neurine, $C_2H_3.N(CH_3)_3OH$, on treatment with moist silver oxide. The base can be also obtained in the same way from the addition product of trimethylamine and ethylene dibromide, $C_2H_4Br.N(CH_3)_3Br$.

Muscarine, $C_5H_{15}NO_3$, occurs in *Agaricus muscarius* (a toad-stool), together with choline ; choline is converted into muscarine by strong nitric acid, so that this latter base is possibly

$$CH(OH)_2.CH_2.N(CH_3)_3OH.$$

Betaine, $C_5H_{11}NO_2$, occurs in the juice of the sugar-beet ; it can be prepared from beet-molasses by diluting with water, precipitating with slight excess of lead acetate, filtering off the precipitate, and decomposing this with dilute sulphuric acid. The acid solution is then precipitated by phosphotungstic acid, and the precipitated phosphotungstate decomposed by milk of lime. The constitution follows from its formation on oxidising choline, and from the fact that it is formed by the action of trimethylamine on chloracetic acid.

$$Cl.CH_2.COOH + N(CH_3)_3 = Cl.N(CH_3)_3.CH_2.COOH$$

The free base has the structure :

$$\begin{matrix} CH_2 - N(CH_3)_3 \\ | \quad\quad | \\ CO - O \end{matrix}$$

Glycocyamine, $C_3H_7N_3O_2$, is obtained either from glycocoll and cyanamide, or by heating glycocoll with guanidine carbonate :

$$CN.NH_2 + H_2N.CH_2.COOH = NH_2.C(NH).NH.CH_2.COOH$$

$$2\,NH_2.CH_2.COOH + (CN_3H_6)_2CO_3 = 2\,C_3H_7N_3O_2 + (NH_4)_2CO_3.$$

This compound, not very soluble in cold water, is thus seen to be guanidine-acetic acid ; the hydrochlorate, when heated to 160°, loses a molecule of water, and gives the hydrochlorate of glyoxyamidine,

$$NH : C\begin{matrix} NH - CO \\ \diagdown \quad | \\ NH - CH_2, \end{matrix} HCl$$

Creatine, $C_4H_9N_3O_2$, found in the flesh of all vertebrate animals, has a neutral reaction, but like glycocoll combines with both acids and salts. It is prepared from meat extract, one part of which is dissolved in 20 parts of water, precipitated with a slight excess of lead acetate, the filtrate freed from lead by hydrogen sulphide and then evaporated to one part. The crystals which separate are washed with 88 per cent. alcohol and recrystallised from water. The constitution is given by Volhard's synthesis from sarcosine and cyanamide which were heated to 100° for some hours in alcoholic solution.

$$\begin{matrix} CH_2 - NH_2.CH_3 \\ | \quad\quad | \\ CO \quad O \end{matrix} + \begin{matrix} CN \\ | \\ NH_2 \end{matrix} = \begin{matrix} CH_2.N(CH_3).C = NH \\ | \quad\quad\quad\quad | \\ CO - O - NH_3 \end{matrix}$$

Boiling with baryta-water decomposes this substance into urea, ammonia, and sarcosine.

Creatinine, $C_4H_7N_3O$, is a normal constituent of human urine; according to Neubauer 1·12 gram is excreted in 24 hours. Voit found a dog would give as much as 4·9 grams per diem if given a large meat diet. Neubauer gives the following method for its preparation:—Urine is quickly evaporated to one-tenth its volume, precipitated with calcium chloride and lime, and after standing 24 hours filtered. The filtrate is then evaporated at a gentle heat to separate sodium chloride, and the mother liquor then treated with $\frac{1}{10}$ volume of concentrated acid-free solution of zinc chloride. After standing three or four weeks the precipitate of $(C_4H_7N_3O)_2ZnCl_2$ is filtered off, washed and digested with lead hydroxide. The filtrate is finally evaporated, and the creatinine separated from creatine by boiling out with alcohol, the former being more soluble.

Creatinine may be artificially prepared by evaporating one part of creatine with one part of sulphuric acid and three parts of water on the water-bath. On decomposing the residue with baryta water a solution of the free base is obtained. Since methylhydantoin and ammonia are formed on hydrolysis with baryta water, creatinine must have the constitution

$$\begin{matrix} CH_2 - N.CH_3 \\ | \quad\quad \diagdown \\ | \quad\quad\quad C = NH \\ | \quad\quad \diagup \\ CO - NH \end{matrix}$$

Certain alkaloids of the fatty series, known as ptomaïnes, are found in decomposing animal matter ; amongst these putrescine may be mentioned. This is apparently tetramethylenediamine $NH_2.CH_2.CH_2.CH_2.CH_2.NH_2$, which, after purification by distillation over sodium, solidifies to leaflets which melt at 24° and boil at 156° to 157°.

The term *alkoloïd* is now getting restricted to naturally occurring vegetable bases which are derivatives of pyridine, quinoline, or other substances containing six-membered rings. Most of them are non-volatile, solid, and contain oxygen : three which contain no oxygen are volatile without decomposition ; these are conine, nicotine, and sparteïne.

The following methods for the extraction and preparation of non-volatile alkaloïds are from Beilstein's *Handbuch der organischen Chemie*. 2te Auflage, Bd. 3, p. 472. The easiest way is to extract the parts of the plant used with dilute acid, and to precipitate the base with an alkali or alkaline earth. For purification the separated base should be taken up by alcohol or ether ; on the small scale it is preferable to use fusel oil, chloroform, or a mixture of equal volumes of chloroform and ether ; the alkaloïd is then removed from the chloroform solution by shaking with dilute hydrochloric acid. The hydrochloric acid solution is then made alkaline, and the base again taken up by chloroform if necessary.

Tannin usually gives precipitates with alkaloïds which can be decomposed by lime ; besides this, precipitates are also formed with many reagents, which can be used either for the detection or the isolation of the alkaloïds as the case may be.

1. A solution of mercuric iodide in potassium iodide gives precipitates from which the alkaloïd can be afterwards recovered by treatment with a solution of stannous chloride in caustic soda. The iodide solution can be prepared from mercuric chloride and excess of potassium iodide.

2. The salts of many alkaloïds give characteristically coloured precipitates (consisting of the sulphides of the alkaloïd and antimony) with Schlippe's salt, Na_3SbS_4.

3. Dragendorff's solution is made by adding a solution of 272 grams of potassium iodide in a small quantity of water to a solution of 80 grams of basic nitrate of bismuth in 200 c.c. of nitric acid of sp. gr. 1·18. The solution is then cooled to separate out crystals of potassium nitrate, and then diluted to one litre. The precipitates obtained from such a solution and a solution of the alkaloïd in hydriodic acid are generally of the type $3NR_4I.2BI_3$; they can be decomposed by soda, and the free base taken up by benzene.

4. Potassium cyanplatinite precipitates the salts, but not the free alkaloïds.

5. Potassium thiocyanate and a metallic salt (*e.g.* zinc sulphate) give precipitates which are insoluble in cold water, easily soluble in alcohol, and decomposable by alkalies.

6. Picric acid does not precipitate all the alkaloïds, though in many cases they can be quantitatively estimated in this way.

7. One of the most useful reagents is phosphomolybdic acid prepared in the following manner:—Ammonium molybdate is precipitated with sodium phosphate, the precipitate well washed, dissolved in warm caustic soda, evaporated to dryness, and the residue ignited. The resulting mass is warmed with water, nitric acid then added until the reaction is strongly acid, and then so much water that one part of the salt mass makes ten parts of solution. The solution will precipitate even the soluble alkaloïds, which may be obtained from the precipitates by treatment with barium carbonate.

8. The cheaper phosphotungstic acid can be used in soda solution, the alkaloïd being dissolved in sulphuric acid, the precipitate is then decomposed by baryta.

9. Animal charcoal removes alkaloïds frequently from their aqueous solutions, they may then be removed from the charcoal by alcohol, chloroform, etc.

Many alkaloïds give red solutions when boiled with aqueous perchloric acid (sp. gr. 1·13–1·14), the solutions show characteristic absorption bands when spectroscopically examined.

Characteristically coloured masses are obtained when many alkaloïds are melted with potash.

Next month the methods for determining the constitution of certain alkaloïds will be taken.

Questions—Advanced.—1. Give the structural formulæ for guanine, xanthine, theobromine, and caffeïne, and state how from the first of these substances the others may be prepared.

2. Describe the method of isolating guanine, and state what happens to it on oxidation. How may guanidine be synthetically obtained?

3. How are theobromine and caffeïne prepared from cocoa beans and tea dust respectively? what characteristics are shown by their salts?

4. How may caffeïne be detected? explain the reaction.

Honours.—1. Do advanced questions.

2. How has Emil Fischer worked out the constitution of caffeïne?

3. Explain the relationship of choline, neurine, muscarine, and betaïne to one another.

4. Describe the preparation of creatine from meat extract, and state how Volhard's synthesis explains its constitution.

5. What is usually understood by the term alkaloïd?

CHEMISTRY NOTES.

BY W. TATE, A.R.C.S., F.C.S.

GENERAL NOTES.—*Solution of solids in vapours :* P. Villard has recently shown that liquid carbon dioxide enclosed in a sealed tube with a little iodine becomes coloured by the latter. Similarly the gaseous carbon dioxide above the liquid exhibits a less intense colouration. In both cases the absorption spectrum does not show the characteristic channelled spaces of gaseous iodine, and it therefore appears warrantable to assume that the gas has really dissolved the iodine.

Argon and Helium : A whole family of elements of the type of argon have been predicted by several scientists. They are placed in Mendeléeff's eighth group, and should possess, like argon, the characteristic of great inertness, having little tendency to enter into combination at all. If any compounds are formed, these elements should be octovalent. No perfectly characterised compounds of argon and helium can yet be said to have been satisfactorily produced.

By the aid of the silent electric discharge, Berthelot asserts that he has caused a certain amount of combination between benzene vapour and argon. Similarly, it is stated that magnesium may be caused to unite with argon by a suitable silent discharge. New sources of these gases have been discovered in certain spring waters of the Pyrenees, which contain small quantities as dissolved gases. Spectroscopic evidence points to the conclusion that other new elements besides argon and helium exist, but they have not yet been satisfactorily isolated, and the matter is hardly yet ripe for discussion.

Atomic Weight of Oxygen : Many determinations have been made in the last few years of the ratio in which hydrogen and oxygen combine to form water, with the result that considerable discrepancies exist between the various results. A recent series of syntheses of water, carried out by Edward J. Morley, in which the hydrogen was absorbed in some 600 grams of palladium and weighed, and the oxygen was weighed in two globes, the combination being effected in a thin glass tube, yielded the following results :—

Density of oxygen, latitude 45° - -	1·4289
Density of hydrogen - - - -	0·08987
Ratio of densities - - - - -	15·900
Volumetric composition of water at 0° C. Ratio of H to O - - - - -	2·0027
Atomic ratio from densities and volumetric ratio - - - - - -	15·879
Atomic ratio from syntheses - - -	15·879
Molecular weight of water from syntheses -	17·878

It will be noticed that the atomic weight deduced, 15·879, differs materially from that usually taken for oxygen, 15·96 ; hence a strong argument in favour of assuming for tables of atomic weights the value O = 16, and giving to the other elements values corresponding to this number. Most atomic weights have been determined with relation to oxygen, and not directly as compared with hydrogen ; hence any alteration of the ratio assumed between the atomic weights of H and O necessarily alters the atomic weights of most other elements if H be taken always as 1. The ratios between these atomic weights and that of oxygen have not in any way altered, and fixing O = 16, the numbers representing most other atomic weights remain unchanged. The only alteration then required to express the results of new determinations of the ratio H : O will be in the value assigned to H. In the present instance, H : O as 1 : 15·879 ; fixing O = 16, this becomes H : O as 1·0076 : 16. So many atomic weights have now been shown not to be exact multiples of that of H, that there is no especial virtue in the value H = 1, and convenience demands the final adoption of the value O = 16.

The above quoted determination illustrates the fact that the ratio of the densities of gases is not always quite the same as the ratio of the atomic weights. This discrepancy arises from the variation shown by the gases concerned, from a strict adherence to Boyle's and Charles' laws. Just in so far as these laws are not *exactly* obeyed, so far Avogadro's hypothesis is not exact. The numbers of molecules in equal volumes of any two gases are only identical at some one determined temperature and pressure—at all other temperatures and pressures the numbers are not quite, though very nearly, identical.

PRACTICAL NOTES.—The South Kensington syllabus shows some important alterations in the practical work required in the Advanced Practical Inorganic Chemistry.

In future the use of notes or text-books of analysis will be permitted. The examination is extended in scope in such a way that it will form a real test of manipulative skill, and will not be easily passed by students working mechanically according to hard and fast systems in which they may have been drilled. The main part of the work in this stage yet consists of the analytical examination of mixtures, but this is supplemented by a simple quantitative exercise, and as each of the higher stages includes the work of the lower stages, it may also be required to recognise materials which have or should have been shown at the lectures.

The qualitative analysis requires a *thorough* study of the reactions of the radicles ; defective work at this stage causes much difficulty afterwards. As an example of the method which may be followed to advantage, the following account of the use of tartaric acid in connection with the alkali metals may be given :—

Tartaric acid, $C_4H_6O_6$, forms two classes of salts, (1) acid salts, as $C_4H_4O_4.OH.OK$; (2) neutral salts, as $C_4H_4O_4(OK)_2$.

The neutral salts of the alkalies are readily soluble in water, but the corresponding acid salts are difficultly soluble—particularly is this the case with potassium and ammonium acid tartrates. As but few of the salts of the alkalies are sparingly soluble, it becomes of importance to inquire into the exact conditions necessary for the production of these acid salts. The ammonium acid tartrate need not be especially considered, as it much resembles the potassium salt, and is not often employed in analysis. Ammonium salts must be invariably removed before testing for potassium by ignition of the residue, obtained on evaporation to dryness of a solution, or of the solid mixture in a fume chamber ; the ammonium compounds volatilize, leaving potassium and sodium compounds. It is with these we have to deal, and, as they may occur in alkaline or acid solutions as well as in neutral solutions, or as solids possessing alkaline, neutral, or acid reaction, we need to study the relations of the acid tartrates to water, alkalies, and acids.

Sodium acid tartrate is a comparatively soluble salt ; it may be precipitated by tartaric acid from solutions of the hydrate or carbonate, but *is not precipitated from neutral solutions.*

Potassium acid tartrate is soluble in 250 parts of water at 10° C., and in 15 parts at 100° C. Alkalies and alkaline carbonates dissolve the precipitated acid potassium tartrate by converting it into the soluble neutral salt.

Potassium acid tartrate is precipitated, by addition of tartaric acid to a neutral solution of a potassium salt and vigorously agitating, as a white crystalline powder ; by slower crystallization it may be procured in prismatic crystals of the rhombic system.

The reaction is represented in the equation—

$$KCl + C_4H_4O_4(OH)_2 = C_4H_4O_4OHOK + HCl,$$

and the solution of the precipitate by the equations—

$$C_4H_4O_4OHOK + KOH = C_4H_4O_4(OK)_2 + H_2O ;$$

$$2C_4H_4O_4OHOK + K_2CO_3 = 2C_4H_4O_4(OK)_2 + H_2O + CO_2.$$

Mineral acids also dissolve the salt, thus—

$$C_4H_4O_4OHOK + HCl = C_4H_4O_4(OH)_2 + KCl.$$

Hence the conditions for the use of tartaric acid as a test for potassium are :—

1. Concentrated solutions of the potassium salt and of the tartaric acid must be used.
2. The test must be made in the cold.
3. The solution tested must be neutral to litmus paper ; if not already neutral it must be neutralized by means of acetic acid or sodium hydrate as may be required. Necessarily, ammonia will not serve for neutralization in this case, as ammonium acid tartrate resembles the potassium salt in insolubility.
4. A large excess of tartaric acid must be used.
5. Ammonium salts must be first driven off by ignition.
6. Finally, metals other than sodium must be absent, as many form white tartrate precipitates. Calcium must be removed with especial care, as small quantities are apt to escape precipitation at the proper point, and then yield a precipitate with tartaric acid.

Provided these conditions are observed, there is no difficulty in utilizing the tartrate test for potassium.

We may consider the alkaline platinichlorides in a similar way.

Platinic chloride combines with the chlorides of the alkalies to form double salts of the type 2RCl.$PtCl_4$. We may write these R_2PtCl_6, and consider them as derivatives of H_2PtCl_6, chloroplatinic acid.

For the reasons given above we must study the relations of the alkaline platinichlorides towards water, acids, and alkalies.

Just as before, ammonium platinichloride resembles the potassium salt closely, but need not be further considered. Both form yellow crystalline precipitates (or orange octahedra). The sodium salt is soluble, and does not interfere with the production of K_2PtCl_6.

Potassium platinum chloride dissolves in 110 parts of water at 10°C., and in 19 parts at 100°. It is much more soluble in the cold than the acid tartrate. It is much more insoluble in alcohol, requiring 12,000 parts for solution, and is quite insoluble in a mixture of alcohol 3 parts and ether 1 part.

Potassium platinum chloride is unacted on by acids, and may be formed from alkaline solutions, as the platinic chloride always contains free acid.

The conditions necessary to ensure precipitation are :—

1. Potassium must be present as chloride, or hydrochloric acid must be present to form chloride. The precipitate may be produced from other salts, but is formed at the expense of $PtCl_4$, thus—

$$4KNO_3 + 3PtCl_4 = Pt(NO_3)_4 + 2K_2PtCl_6.$$

2. The solutions used must be concentrated.
3. Ammonium salts must be absent.

The reaction is much more delicate if alcohol be added, but this procedure involves the disadvantage that sulphates and phosphates may be precipitated on addition of the alcohol, and may be mistaken by the tyro for the platinichloride sought.

Questions.

1. What classes of salts yield a fusible residue when strongly heated before the blowpipe on charcoal or on platinum foil?—(S. & A. D., 1895.)
2. What are the exact conditions under which the tartaric acid test can be used in the detection of potassium?
3. Define clearly the advantages of platinic chloride as compared with tartaric acid when used as a reagent for the detection of potassium.
4. What do you understand by the terms acid, alkali, salt, base? How would you distinguish a basic salt and an acid salt, respectively, from a base, from a neutral salt, and from an acid?
5. Classify the reactions by which hydrogen may be produced, giving equations where possible.

SCIENCE NOTES.

Crystalline Bromine.—Quite recently it has been found possible to obtain bromine in the solid form. By dissolving the element in carbon disulphide till the solution was very concentrated, and then cooling to — 90° C., the bromine separated from the solvent in fine dark needles, carmine red in colour, and of a length of several millimetres. In the mass bromine has a crystalline fracture without any well-defined metallic lustre.

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'Flora of Berkshire.'—Since the publication of his 'Flora of Oxfordshire,' Mr. Claridge Druce, of Oxford, one of the best-known of English systematic botanists, has devoted a considerable portion of his leisure time to the compilation of a 'Flora of Berkshire.' This will form a volume of about five hundred pages, and will be a history of the county, as well as a catalogue of its plants. Brief sketches will be given in the book of the topography, meteorology, geology, river-drainage, and physiography of the district, as well as short biographies of botanists who have investigated the Berkshire flora.

***

Death of Dr. J. E. Taylor.—Natural history, though often despised to a certain extent among those who fancy that the microscope is the only instrument worthy of the use of those who study the phenomena of life, has yet numbered among its votaries many earnest workers who have left their names conspicuous among both botanists and zoologists. Few men did more to popularise these studies than the late Rev. J. G. Wood, whose works are so fascinating by reason of the stimulus they give to youthful enthusiasm. Another notable worker in the same field has lately departed from us, leaving the world the poorer for his loss. For more than twenty years Dr. J. E. Taylor was Curator of the Natural History Museum at Ipswich, perhaps the best provincial collection of its kind. With Ipswich, his work is, perhaps, most closely associated, but his name was far more widely known. He was the author of a number of books, chiefly on botanical and geological subjects. He also published a guide to Suffolk, and an account of a naturalist's holiday in Australia, under the title of 'Our Island-Continent.' Among his natural history writings may be mentioned 'Half-hours in the Green Lanes,' which has passed during the last twenty years through seven editions. 'Half-hours by the Seaside' was another work, which also had a large sale. Dr. Taylor was for many years the Editor of the illustrated monthly scientific journal 'Science Gossip.' He was a Fellow of the Linnean and Geological Societies.

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A Great Naphtha Spring.—According to information received from Grosni, in the Terek Territory, a fresh naphtha spring has been opened there. The jet is stated to be of immense height, and it is expected that it will discharge nearly thirty million poods of naphtha daily.

***

Prizes for Research.—The Royal Society of New South Wales is offering its medal and valuable prizes in money for original investigations in certain fields of science. Among the subjects which they suggest as likely to yield valuable results to the Colony are the following:—The physiological action of any Australian spider, snake, or tick; the chemistry of the Australian gums and resins; the chemical composition of the products from the so-called *kerosene shale* of New South Wales. The competition is not subject to any restrictions, and the successful papers will be published in the Society's annual volume, fifty reprints being furnished to the authors, free of expense.

***

Further Investigations into the Properties of Argon and Helium.—It has been found by Bouchard that the gases disengaged from certain sulphurous waters in the Pyrenees contain, besides nitrogen, etc., a certain quantity of both argon and helium. Troost and Ouvrard, experimenting with the gases he obtained, were able to show that they combine, under certain conditions, with magnesium. They require to be brought into contact with the vapour from the metal; the combination is then brought about under the prolonged influence of powerful shocks from a Ruhmkorf coil. Platinum is also said to present the same phenomena of vaporisation and combination with argon under similar conditions to those described.

***

Preservation of Chloroform.—A recent discovery by Allain promises to be of considerable value. He finds that chloroform can be preserved almost indefinitely by saturating it with sulphur. Chemically pure chloroform is taken, and the sulphur is prepared from ordinary sublimed sulphur by leaving it in contact with four times its weight of pure caustic ammonia for twenty-four hours. It is then washed with distilled water, till all traces of alkali are removed, and placed in a stove at a temperature of 40° C. for a period of four days. It is then dried over strong sulphuric acid for about a fortnight. Purified chloroform exposed to direct sunlight gave a precipitate, with argentic nitrate solution, after about forty-eight hours, but underwent no change under similar circumstances if previously saturated with sulphur, except that there was a deposit of insoluble sulphur. Specimens thus treated have been exposed to sunlight for four months without any alteration that could be detected by the usual reagents, and were found to cause perfectly normal anæsthesia in man and the lower animals without accident. In diffused light the addition of one-thousandth part its weight of sulphur preserved chloroform indefinitely in the presence of a great excess of oxygen.

***

Preservation of Milk.—A new preservative for milk is being introduced in the shape of potassium chromate. It is said that 0·1 gramme of this salt will preserve milk for twenty-four hours, 0·25 grammes for twelve to fifteen days. The neutral chromate is sometimes used, but instead a mixture may be taken consisting of one part of the former with two parts of the bichromate. On the whole, the new method seems likely to be deleterious to the consumer, however it may benefit the vendor, for the chromates are certainly poisonous, causing serious intestinal troubles. The adulteration can be detected by the use of a little nitrate of silver in weak solution, which produces an orange red precipitate of chromate of silver. The test is very delicate.

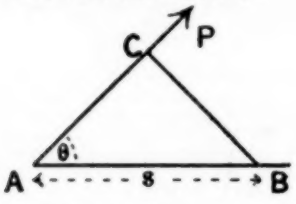
NOTES ON THEORETICAL MECHANICS.

ADVANCED AND HONOURS STAGES.

BY F. CASTLE, M.I.M.E.

The conditions of equilibrium are of fundamental importance in statics; but it is evident that when there is equilibrium there is no motion, and, therefore, no work is done. The work done by a force has already been shown to be the product of the force into the displacement of its point of application in the direction of the force. When the point of application of the force is displaced through a small space the resolved part of the displacement in the direction of the force is called its *virtual velocity*. This is a positive or negative quantity according as it is in the same or opposite direction to that of the force. Let a force P, acting along the line AC at an angle θ to AB, displace a particle from A to B; draw BC perpendicular to AC meeting AC at C; then AC is the projection of the displacement on the line of action of P, and the work done by P is $P \times AC = P \cdot s \cos\theta$ (where $s = AB$). It may be noted that when θ is 0°, the work done by P is $P \times s$; when θ is 90° no work is done by the force (the point of application perpendicular to the direction in which the force acts); thus in the simple pendulum the tension of the string is a force always perpendicular to the direction in which the mass at the end is moving, and no work is done by the force. When θ exceeds 90°, negative work is done, or work is done against the force. If there are any number of forces acting on a particle at A, the algebraical sum of the work done by all the forces

through any small displacement AB is equal to the work done by their resultant. Let P denote one of the forces.



Work done by P = P . AC = P . $s \cos\theta$.
Sum of work done = $s \Sigma P \cos\theta$
= $s \times$ (resolved part of resultant along AB)
= work done by resultant.

Since the algebraic sum of the work done by all the forces acting on a particle due to a slight displacement is equal to the work done by their resultant, it follows that for any system of forces in equilibrium acting on a particle, the *algebraical sum of the virtual work done by all the forces for any small (or virtual) displacement is zero*, and conversely, *if the algebraical sum be zero, the forces are in equilibrium.*

Sometimes the product P . AC = P . $s \cos\theta$ is called the *virtual moment* of the force, then *the algebraical sum of the virtual moments of any system of forces in equilibrium is zero ;* this is called the principle of *virtual velocities* or the *principle of work*, and gives the means by which the ratio of two forces which keeps a machine in equilibrium is determined, these being applied in given ways to the same body or machine. This applies not only to the so-called simple machines, *i.e.*, lever, wheel and axle, screw, etc., but also in hydrostatics.

Thus, in the case of any two forces applied to a machine and tending to drive it in opposite directions, the conditions of equilibrium require that during any small movement of the machine the two forces will do equal and opposite amounts of work. The two forces are often termed the power and weight respectively. It is better to restrict the term power to the rate of doing work ; thus the two forces, although designated by P and W, may be called the force P and the weight or force W. If the process of doing work be described as the exertion of energy, the equation can be written

Energy exerted = work done.

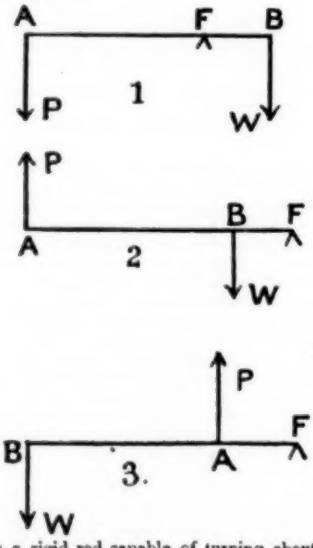
The effect of friction is to make the useful work done less than the energy exerted, and the equation may be written

Energy exerted = useful work done + work lost in friction.

The efficiency of the machine is the ratio of the useful work done to the energy exerted.

$$\therefore \text{ efficiency} = \frac{\text{useful work}}{\text{energy exerted}}$$

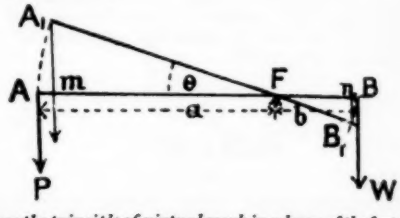
A *machine* is an instrument by means of which a force or forces applied at one point may be made to do work or overcome resistance at some other point.



The *lever* is a rigid rod capable of turning about a fixed point called the axis or fulcrum. The forces P and W may act on the same or opposite sides of the fulcrum F ; the portions AF and BF between the fulcrum and the points of application of P and W are called the *arms* of the lever. It is usual to divide levers into three classes or orders ; these are marked on the figures by numerals 1, 2, 3. In levers of the first order, P and W are on opposite sides of the fulcrum ; the three parallel forces acting are P, W, and the resultant R = P + W; for equilibrium the algebraical sum of the moments of P and W about F must be zero.

$$\therefore P \times AF = W \times BF,$$

or the moment of P about F is equal to the moment of W about the same point, the lengths AF and BF are perpendicular to P and W, and the equation obtained applies to all the three kinds of levers ; the pressure on the fulcrum is the resultant of the parallel forces P and W, and is P + W, W − P, and P − W, in the first, second, and third kinds respectively.



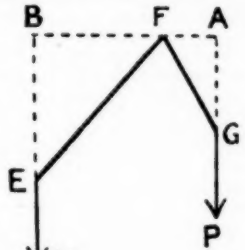
To prove the principle of virtual work in a lever of the first order.— Let AFB be a lever movable about F, and suppose the lever to be displaced through a small angle θ, so that A moves to A_1 and B to B_1. (The forces P and W are supposed to act at right angles to the rod during the motion.) Let AF and BF equal a and b respectively, making use of the well-known relation that angle = $\frac{\text{arc}}{\text{radius}}$, then $AA_1 = a.\theta$ and $BB_1 = b.\theta$, the reaction of the fulcrum does no work, and therefore $P \times AA_1 - W \times BB_1 = 0$.

$$\therefore P \times a.\theta = W \times b.\theta \quad \text{or} \quad P \times a = W \times b.$$

Or if we assume P and W to remain vertical throughout the motion, and A_1m . B_1n be drawn perpendicular to and meeting AB in m and n, then work done on P is $P \times A_1m$, and work done on W is $W \times B_1n$.

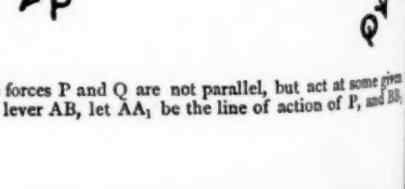
$$\therefore P \times A_1m = W \times B_1n \text{ ; but } \frac{A_1m}{B_1n} = \frac{FA_1}{FB_1} = \frac{FA}{FB},$$

i.e., as before, we obtain $P \times a = W \times b$, the same result as that obtained by the principle of moments when the machine is at rest.



In the case of the bent lever EFG, let EB represent the direction of the weight W and AG that of P. Draw FA and FB perpendicular to EB and GA respectively. Taking moments about F there will be equilibrium when

$$W \times BF = P \times AF.$$



When the forces P and Q are not parallel, but act at some given angle to the lever AB, let AA_1 be the line of action of P, and BB_1

the line of action of Q; draw CM . CN perpendicular to AA_1 and BB_1 respectively; then taking moments about the fulcrum C, P and Q will be in equilibrium when $P \times CM = Q \times CN$.

If the lengths AC and CB be known, also the angles CAM and CBN, CM and CN can be found.

(*To be continued.*)

MATHEMATICS.

STAGES 2 AND 3, SCIENCE AND ART DEPARTMENT.

BY G. A. BAXANDALL,

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STAGE 2.

Algebra.

It is scarcely possible to render much assistance to a student in working examples on square root. It is simply a question of applying a rigid rule a sufficient number of times to enable him to become familiar with it. The rule is clearly explained in the two text-books.

If the expression whose square root is required contain any factors, these should, as a rule, be multiplied out. Also, if fractions appear, the whole expression may be reduced to a single fraction by finding the L.C.M., the square root of numerator and denominator being then found. But it is not *necessary* to first get rid of the fractions; the rule may be applied at once.

The terms of the expression should be re-arranged (when necessary) in descending powers of one of the letters. Thus the three expressions :—

$$6acx^5 + 4b^2x^4 + a^2x^{10} + 9c^2 - 12bcx^2 - 4abx^7,$$

$$ab^2 + 9b^2 - 12ab - \frac{3b^3}{2} + \frac{b^4}{16} + 4a^2,$$

$$25\tfrac{3}{7} - \frac{20x}{7y} + \frac{9y^2}{16x^2} - \frac{15y}{2x} + \frac{4x^2}{49y^2},$$

should be written :—

$$a^2x^{10} - 4abx^7 + 6acx^5 + 4b^2x^4 - 12bcx^2 + 9c^2,$$

$$\frac{b^4}{16} - \frac{3b^3}{2} + ab^2 + 9b^2 - 12ab + 4a^2,$$

$$\frac{4x^2}{49y^2} - \frac{20}{7}\frac{x}{y} + 25\tfrac{3}{7} - \frac{15}{2}\frac{y}{x} + \frac{9y^2}{16x^2},$$

the last being the same as :—

$$\frac{4}{49}\left(\frac{x}{y}\right)^2 - \frac{20}{7}\left(\frac{x}{y}\right) + 25\tfrac{3}{7} - \frac{15}{2}\frac{1}{\left(\frac{x}{y}\right)} + \frac{9}{16}\frac{1}{\left(\frac{x}{y}\right)^2},$$

which is arranged in descending powers of $\frac{x}{y}$, the number $25\frac{3}{7}$ coming between $\frac{x}{y}$ and $\frac{1}{\frac{x}{y}}$.

Work—H.S., Exs. LXXXI., Nos. 1, 6, 7, 9, 12, 15, 18; or H.K., Exs. XVI.*c*, Nos. 3, 8, 10, 11, 15, 17.

Also the following :—

5. Extract the square root of

$$x^6 - 4x^5y + 10x^4y^2 - 20x^3y^3 + 25x^2y^4 - 24xy^5 + 16y^6.$$

Ans. $x^3 - 2x^2y + 3xy^2 - 4y^3$.

6. Extract the square root of

$$\frac{a^2}{x^2} + \frac{ab}{xy} + \frac{b^2}{4y^2} - \frac{6ac}{xz} - \frac{3bc}{yz} + \frac{9c^2}{z^2}.$$

Ans. $\frac{a}{x} + \frac{b}{2y} - \frac{3c}{z}$.

7. Extract the square root of

$$25\tfrac{3}{7} - \frac{20x}{7y} + \frac{9y^2}{16x^2} - \frac{15y}{2x} + \frac{4x^2}{49y^2}.$$

Ans. $\frac{2x}{7y} - 5 + \frac{3y}{4x}$.

8. Extract the square root of

$$a^4 + b^4 + c^4 + d^4 - 2a^2(b^2 + d^2) - 2b^2(c^2 - d^2) + 2c^2(a^2 - d^2).$$

Ans. $a^2 - b^2 + c^2 - d^2$.

Trigonometry.

Ex. 3. (*October*).—The circular measure of an angle is the *number* of radians contained by it. Or if the angle be ABC, and an arc be described with B as centre, and with any radius, so as to intersect AB and CB in D and E, then the circular measure of ABC is $\frac{\text{arc DE}}{\text{radius}}$.

Using the latter definition we get circular measure of a right angle $= \frac{\frac{1}{4}\text{ circum.}}{\text{radius}} = \frac{\frac{1}{4}\,2\pi r}{r} = \frac{\pi}{2}$.

To express 44° as a fraction of the angle whose circular measure is 1·5, we must reduce the latter to degrees; that is, $\left(1{\cdot}5 \times \frac{180}{\pi}\right)^\circ$, the required fraction will then be :

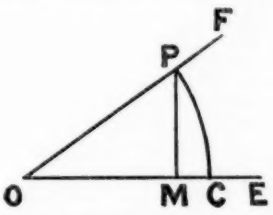
$$\frac{44}{1{\cdot}5 \times \frac{180}{\pi}} = \frac{\pi \times 44 \times 2}{180 \times 3} = \frac{22}{7}\frac{44 \times 2}{180 \times 3} = \frac{484}{945}.$$

Ex. 5. (*October*).—The number of divisions (minutes) between the hour hand and minute hand at 20 minutes to 6 = 10 + $\frac{1}{3}$ of 5 = $11\frac{2}{3}$, and since each minute corresponds to 6°, the angle in question

$$= 6 \times 11\tfrac{2}{3} = 70^\circ$$
$$= 70 \times \tfrac{10}{9} = 77\tfrac{7}{9}\text{ grades}$$
$$= 70 \times \frac{\pi}{180} = \frac{7\pi}{18}\text{ radians.}$$

An acquaintance must now be made with the trigonometrical ratios of an angle, the latter being taken to be *acute* for the present.

Read—H.S., Arts. 51 to 56; or Lock, Arts. 75 to 82.



For convenience, the definitions are here given :—

Let FOE be any acute angle. Take any point P in either line, say in FO, and draw PM perpendicular to OE.

Then,

$$\sin \text{FOE} = \frac{\text{PM}}{\text{OP}}, \quad \text{cosec FOE} = \frac{\text{OP}}{\text{PM}},$$

$$\cos \text{FOE} = \frac{\text{OM}}{\text{OP}}, \quad \sec \text{FOE} = \frac{\text{OP}}{\text{OM}},$$

$$\tan \text{FOE} = \frac{\text{PM}}{\text{OM}}, \quad \cot \text{FOE} = \frac{\text{OM}}{\text{PM}},$$

to which we may add,

$$\text{circular measure of FOE} = \frac{\text{arc PC}}{\text{OP}}.$$

These must be committed to memory, and this should be done by working a large number of examples similar to those given below. Before working these examples the student should make one observation, namely, that in each of the six ratios there occur two sides of a right-angle triangle. Now if two sides be given, the third is obtained by Euc. I. 47, from which it follows that if any of the six ratios be given, the other five can be obtained from it.

Work—H.S., Exs. XVIII., or Lock, Exs. XVII.

Also the following :—

6. In a triangle ABC, B is a right angle, BC = 25 feet, and AC = 65 feet, find AB, and write down all the trigonometrical ratios of the angle A.

7. Two poles (whose diameters may be neglected) stand vertically out of the ground, their heights being 20 feet and 30 feet respectively; the distance between the poles is 20 feet. A person 5 feet high is so placed that when standing on the ground (which is horizontal) he can see the whole of the shorter pole, but only 5 feet of the longer one. Find his distance from the latter. Ans. 100 feet.

8. Which of the following equations are possible and which impossible ?

2 sin A = 3.	9 cos B = 5.
2 sec C − 1 = 0.	2 tan D = 117.

10. If A, B, and C be three acute angles, such that sin A, cos B, and tan C are in the ratio 1 : 2 : 3, show that sin A cannot be greater than $\frac{1}{2}$, and tan C cannot be greater than $1\frac{1}{2}$.

11. If sin A, cos B, and tan C are in the ratio of 2 : 3 : 4, show that—

$$\cos^2 A + \sin^2 B + \tfrac{1}{16}\sec^2 C = 2\tfrac{1}{16}.$$

12. If $\tan\theta = \frac{1}{\sqrt{7}}$, find the value of $\frac{\operatorname{cosec}^2\theta - \sec^2\theta}{\operatorname{cosec}^2\theta + \sec^2\theta}$.

Ans. $\frac{3}{4}$.

13. If $\tan\theta = \frac{2x(x+1)}{2x+1}$, find $\sin\theta$ and $\cos\theta$.

Ans. $\frac{2x(x+1)}{2x^2+2x+1}$; $\frac{2x+1}{2x^2+2x+1}$.

Euclid.

Ex. 2 (*October*).—The line AD being divided at C we obtain by Euc. II. 4 :

$$AD^2 = AC^2 + CD^2 + 2AC.CD.$$

Similarly, since C divides BD, we get

$$BC^2 + CD^2 + 2BC.CD = BD^2;$$

whence by adding we get

$$AD^2 + BC^2 + CD^2 + 2BC.CD = AC^2 + BD^2 + CD^2 + 2AC.CD,$$

$$BC^2 + AD^2 = 2AC^2 + 2AC.CD - 2BC.CD$$

$$= 2AC^2 + 2CD(AC - BC)$$

$$= 2AC^2 + 2CD^2. \quad Q.E.D.$$

Ex. 3 (*October*).—Let AB be divided at C, then by Euc. II. 7, we get—

$$AB^2 + BC^2 = 2AB.BC + AC^2;$$

$$\therefore 2AB.BC = AB^2 + BC^2 - AC^2.$$

On AB construct a square ABDE; draw the diagonal BE intersecting at F a line through C parallel to BD. Then since EB is divided at F, we get from Euc. II. 7 :—

$$EB^2 + FB^2 = EF^2 + 2EB.BF,$$

$$2EB.BF = EB^2 + FB^2 - EF^2$$

$$= 2AB^2 + 2BC^2 - 2AC^2 \text{ (I. 47)}$$

$$= 4AB.BC;$$

$$\therefore EB.BF = 2AB.BC. \quad Q.E.D.$$

Read—Propositions 9, 10, 11, in Book II.

Work the following riders :—

5. If any point within a rectangle be joined to its corners, show that the sum of the squares of the lines drawn to a pair of opposite corners is equal to the sum of the squares on the lines drawn to the other pair of corners.

6. If four points, A, B, C, D, are in order on a straight line, prove that the rectangle contained by AC and BD is equal the sum of the rectangles contained by AB, CD, and BC, AD.

7. ABC is an isosceles triangle, and MN is drawn parallel to the base BC, M and N being on the equal sides AB, AC; prove that if BN is joined, $BN^2 = CN^2 + BC.MN$.

8. Divide a given straight line into two such parts that the square on one of them may be double the square on the other.

STAGE 3.

Algebra.

Ex. 3 (*October*).—The permutations consists of two lots.

(*a*) Those containing 3 different letters.

(*b*) ,, ,, 2 like letters.

(*a*) The required number $= {}_{26}P_3 = 26.25.24$.

(*b*) There are 26 pairs of like letters, with each of which there are 25 ways of associating a different letter. Thus there are 26×25 *groups* of 3 letters, each group containing two like letters. From each group we can get $\frac{|3}{|2}$ permutations, or $\frac{|3}{|2} \times 26$, 75 in all.

Hence the required answer $26.25.24 + 3 \times 20.25 = 27.26.25$.

Ex. 4. Suppose that the three cocoa-nuts are distinguishable, each from the others, the same remark applying to the apples and oranges. Consider the nuts first. We can select 1 in 3 ways, 2 in 3 ways, 3 in 1 way, giving 7 selections in all. From the apples we could select 1 in 4 ways, 2 in 6 ways, 3 in 4 ways, and 4 in 1 way, making 15 selections. There will, therefore, be 7×15 possible selections from the nuts and apples. Continuing, 1 orange can be selected in 2 ways, and 2 in 1 way, giving 3 selections in all. Hence the required number of possible selections is $7 \times 15 \times 3 = 315$.

Ex. 5. (1) Let each number consist of 4 digits; then there are 4 places to fill up with digits. The left-hand place can be filled in 7 ways only, for 0 must not come first, and when it has been filled up in any one way, there are 7 ways of filling up the next. There are therefore 7×7 ways of filling up the first two places; and when they have been filled up in any one of these ways, there are 6 ways of filling up the third place. Thus there are $7 \times 7 \times 6$ ways of filling up three places, and when they have been filled up in any one of these ways, there are 5 ways of filling up the last place, thus giving $7 \times 7 \times 6 \times 5$ numbers of 4 digits.

Similarly there are $7 \times 7 \times 6$ with 3 digits, 7×7 with 2 digits, and 7 with one digit, making 1,820 in all.

(2) In this case any digit may be used 1, 2, 3, or 4 times. Applying the same reasoning as above, the required number will be seen to be $7 \times 8 \times 8 \times 8 + 7 \times 8 \times 8 + 7 \times 8 + 7 = 4{,}095$.

Read—Tod. Arts. 499, 501, 502, or H.K. 152 to 157.

We are not in a position at present to establish formulæ for the *numbers of combinations and permutations* r *letters at a time, when there are* n *letters which are not all different.* The following is a numerical example which illustrates the *exhaustive* method:—

Example.—Find the numbers of combinations and permutations of 4 letters each which can be formed from the letters of the word *consonants.*

There are 10 letters, but only 6 different ones.

We must find—

(1) Combinations consisting of 4 different letters.
(2) ,, ,, of 2 o's and 2 different letters.
(3) 2 n's and 2 other different letters.
(4) 2 s's ,, ,, ,,
(5) 2 o's and 2 n's, 2 o's and 2 s's, 2 n's and 2 s's.
(6) 3 n's and 1 different letter.

The number of contributions will be—

(1) ${}_6C_4$; (2) ${}_5C_2$; (3) ${}_5C_2$; (4) ${}_5C_2$; (5) 3; (6) 5, giving a total of $15 + 10 + 10 + 10 + 3 + 5 = 53$.

The corresponding permutations will be—

(1) $15|4$; (2) $10\frac{|4}{|2}$; (3) $10\frac{|4}{|2}$; (4) $10\frac{|4}{|2}$; (5) $3\frac{|4}{|2|2}$; (6) $5\frac{|4}{|3}$

giving a total of $360 + 120 + 120 + 120 + 18 + 20 = 758$.

By way of illustrating Art. 153, H.K., we may consider the following problem:—

Example.—In how many ways is it possible to draw a sum of money from a bag containing a sovereign, a half-sovereign, a crown, a florin, a shilling, a penny, and a farthing?

This problem is equivalent to that of finding the total number of combinations from 7 things, taking them every possible number at a time.

We require to observe that in making a draw, we either *take* a farthing or *leave* it—*two* distinct acts, and this applies to each coin. Now if there were two coins only, each act relating to one coin could be combined with each act relating to the other, giving 2×2 combinations. Each of these combinations could be further associated with each act relating to a third coin, thus giving $2 \times 2 \times 2$ combinations, one of these 8 being the result of not taking any of the three coins, and this of course would not count. Proceeding in this way it will be seen that the total number of sums is $2^7 - 1$.

Work—Tod. Exs. XXXIV. 24, 28, 36, 37, or H.K. Exs. XI. XI.*b*, 1, 6, 5, 8, 16, 27.

Also the following :—

7. Three persons have four coats, five vests, and six hats between them, in how many different ways can they dress themselves with them? Ans. 172,800.

8. With 17 consonants and 5 vowels, how many words can be formed having 2 different vowels in the middle and 1 consonant (repeated or different) at each end? Ans. 5,780.

9. If the number of combinations of $2n$ things taken $n-1$ together be to the number of combinations of $2(n-1)$ things taken n together as 132 is to 35, find n. Ans. 6.

10. Find the number of different arrangements that can be made of bars of the seven prismatic colours, so that the blue and the green bars shall never come together. Ans. 3,600.

11. There are 4 regular solids marked on each face with a different symbol. The numbers of their faces are 4, 6, 8, 12 respectively. How many different throws are possible taking them altogether? Ans. 2,304.

12. In how many ways can the letters in the word *multiple* be rearranged? (1) Without altering the *order* of the

vowels. (2) Without altering the *places* of the vowels. (3) Without altering the *relative order* of the vowels and consonants. Ans. (1) 3,359, (2) 59, (3) 359.

13. Having five sovereigns and five shillings in my pocket, I am asked for a subscription; between how many different amounts have I choice? Ans. 35.

Trigonometry.

Ex. 3 (*October*).—Prove that—

$$\cos^2(A-B)+\cos^2B-2\cos(A-B)\cos A\,.\,\cos B=\sin^2A.$$

Left-hand side $=\cos^2(A-B)+\cos^2B-\cos(A-B)[\cos(A+B)+\cos(A-B)]$

$=\cos^2B-\cos(A-B)\,.\,\cos(A+B)$

$=\cos^2B-\frac{1}{2}(\cos 2A+\cos 2B)$

$=\cos^2B-\frac{1}{2}(1-2\sin^2A+2\cos^2A-1)$

$=\sin^2A.$

Ex. 6 (*October*).—Prove that—

$$2\cos\frac{\pi}{13}\,.\,\cos\frac{9\pi}{13}+\cos\frac{3\pi}{13}+\cos\frac{5\pi}{13}=0.$$

Left-hand side $=\cos\frac{10\pi}{13}+\cos\frac{8\pi}{13}+\cos\frac{3\pi}{13}+\cos\frac{5\pi}{13}$

$=\cos\frac{10\pi}{13}+\cos\frac{3\pi}{13}+\cos\frac{8\pi}{13}+\cos\frac{5\pi}{13}$

$=2\cos\frac{\pi}{2}\,.\,\cos\frac{7\pi}{26}+2\cos\frac{\pi}{2}\,.\,\cos\frac{3\pi}{26}$

$=0.$

Read—Tod. Chap. VII., or Loney, Chap. VIII.

In these chapters appear the formulæ for the sin, cos, and tan of multiple and submultiple angles. With regard to the case of multiple angles, the formulæ present little difficulty, but those for submultiple angles require very careful consideration on account of the ambiguity due to the double signs which enter into the formulæ.

Without making any detailed explanations, we may take a general view of what is done in the above chapters. From the formulæ—

$$\sin A=2\sin\frac{A}{2}\cos\frac{A}{2};$$

$$\cos A=\cos^2\frac{A}{2}-\sin^2\frac{A}{2}=2\cos^2\frac{A}{2}-1=1-2\sin^2\frac{A}{2};$$

$$\tan A=\frac{2\tan\frac{A}{2}}{1-\tan^2\frac{A}{2}}$$

another set can be readily obtained, viz.—

$$\sin\frac{A}{2}=\pm\sqrt{\frac{1-\cos A}{2}},\quad \cos\frac{A}{2}=\pm\sqrt{\frac{1+\cos A}{2}};$$

$$\tan\frac{A}{2}=\pm\sqrt{\frac{1-\cos A}{1+\cos A}};$$

$$2\sin\frac{A}{2}=\pm\sqrt{1+\sin A}\pm\sqrt{1-\sin A};$$

$$2\cos\frac{A}{2}=\pm\sqrt{1+\sin A}\mp\sqrt{1-\sin A};$$

$$\tan\frac{A}{2}=\frac{\pm\sqrt{1+\tan^2A}-1}{\tan A}.$$

Now, if the *numerical value* of sin A, cos A, or tan A be given *only*, then on substituting in its value on the right hand side, we shall be unable to settle which of the two signs to take, that is, there will be ambiguity. For example, if we know that $\sin A=\frac{1}{2}$, we do not know whether A is 30°, 150°, 390° and so on, and therefore whether $\frac{A}{2}$ is 15°, 75°, 195° and so on, hence we cannot tell what sign to attach to $\sin\frac{A}{2}$, $\cos\frac{A}{2}$, or $\tan\frac{A}{2}$ as the case may be.

If on the other hand, we do know the value of A in addition to the numerical value of its sine, cosine, or tangent, then we shall know $\frac{A}{2}$, and therefore the sign of $\sin\frac{A}{2}$, $\cos\frac{A}{2}$, $\tan\frac{A}{2}$ will be known, and no ambiguity will exist.

Work—Tod. Exs. to Chap. VII., Nos. 1 to 13, 18, 24, 28, or Loney, Exs. XVIII. 23 to 29, 7, 3, 4, 6. Also the following, the solutions to some of which will be given next month :—

7. Prove that $\cos^6\theta+\sin^6\theta=\frac{1}{8}(5+3\cos 4\theta)$.

8. Prove that $\sin 10A+\sin 10B+\sin 10C=4\sin 5A.\sin 5B.\sin 5C$, where $A+B+C=\pi$.

9. Prove that—

$$\cos^2\frac{\pi}{11}+\cos^2\frac{2\pi}{11}+\cos^2\frac{3\pi}{11}+\cos^2\frac{4\pi}{11}+\cos^2\frac{5\pi}{11}=\frac{9}{4}.$$

10. Show that $\cos A=\sin(54°+A)+\sin(54°-A)-\sin(18°+A)-\sin(18°-A)$.

11. If $a\tan\theta=b$, prove that $a\cos 2\theta+b\sin 2\theta=a$.

12. Prove that $\cos\frac{\pi}{7}\,.\,\cos\frac{2\pi}{7}\,.\,\cos\frac{3\pi}{7}=\frac{1}{8}$.

Euclid.

Ex. 3 (*October*).—$(CP+AP)^2=CP^2+2CP.AP+AP^2$

$=AC^2+2CP.AP.$

Since AC^2 is constant, $(CP+AP)^2$ is maximum when CP.AP is maximum, that is, when $CP^2.AP^2$ is maximum, that is, when $CP^2=AP^2$, for CP^2+AP^2 is constant. Therefore CP + AP is maximum when CP = AP.

Theorem.—*If a point move so that the difference of the squares of its distances from two fixed points is constant, its locus is a straight line.*

Let A, B be any two fixed points, and CD a line drawn through C at right angles to AB. Then for any point P on CD—

$$PA^2-PB^2=PC^2+AC^2-(PC^2+CB^2)$$

$$=AC^2-CB^2=\text{constant}.$$

Hence if $PA^2-PB^2=$ a constant, P lies on a line through C at right angles to AB, where C is such that $AC^2-CB^2=$ given constant.

Ex. 5 (*October*).—Let A, B be the centres of the given circles, and P a point from which the tangents PN, PM are equal. Then the locus of P shall be a straight line, for

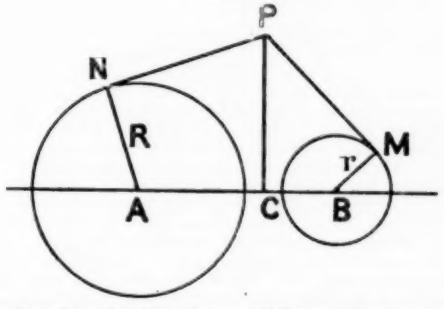
$$PN^2=PA^2-AN^2,$$

$$PM^2=PB^2-BM^2;$$

$$\therefore\ PA^2-AN^2=PB^2-BM^2,$$

$$PA^2-PB^2=AN^2-BM^2$$

$$=\text{constant}.$$



Therefore, from the above theorem, P lies on a line perpendicular to AB and passing through C, a point in AB such that $AC^2-BC^2=AN^2-BM^2=R^2-r^2$.

This line is called the *radical axis* of the two circles. If the circles intersect, it at once follows from III. 36 that the radical axis is the line passing through the points of intersection of the circles.

Now let us suppose B to approach A, the circles remaining unaltered in size. That is, let AB become gradually smaller, R^2-r^2 remaining constant. The question arises, how does the radical axis alter its position? or how does C move?

A few particular positions may be observed :—(1) When the circles touch externally, their common tangent at their point of contact becomes the radical axis, C still being on the left of B. (2) As B moves further it will come to a position such that the common chord (which is the radical axis) passes through B, in which case B and C coincide. (3) When the circles touch internally, their common tangent is the radical axis, C being now to the right of B. As B moves more to the left, C will move off to the right. Where is C when B is very close to A? We observe that

$$AC^2-BC^2=R^2-r^2=\text{const.}$$

$$AC^2-(AC-AB)^2=\text{const.}$$

$$2AC\,.\,AB-AB^2=\text{const.}$$

Now AB is to be very small, and therefore AB^2 is negligible. How, therefore, can 2AC. AB remain constant when AB is indefinitely small? The answer is, by AC becoming indefinitely large at the same time. That is, the radical axis moves to a point an infinite distance to the right of A as the circles become concentric.

Work the following:—

6. Show that the bisectors of the angles formed by producing the opposite sides of a cyclic quadrilateral (that is, a quadrilateral around which a circle can be described) to meet, are at right angles.

7. A and B are fixed points within a fixed circle; if P is a variable point on the circle, and PA, PB produced meet the circle in X, Y, find when XY is greatest.

8. Through a point P within a rectangle ABCD, parallels are drawn to the sides; and P moves so that the difference of the rectangles PA, PC is constant; find the locus of P.

9. AB is a fixed line, O a fixed point, and MN a fixed length; if a variable point P moves so that $PQ^2 = PQ.MN$, (PQ being the perpendicular from P on to AB), find the locus of P.

SCIENCE AND ART CIRCULAR.

DEPARTMENT OF SCIENCE AND ART OF THE COMMITTEE OF COUNCIL ON EDUCATION, LONDON, S.W.

'South Kensington,
'16th October 1895.

'Sir,—I am directed to forward herewith, for the information of your Committee, copies of a Minute by the Lords of the Committee of Council on Education with regard to attendance grants in Science and Art Schools to which the Lords Commissioners of Her Majesty's Treasury have given their sanction as an experiment for a limited time.

'I am, Sir,
'Your obedient Servant,
'J. F. D. DONNELLY.'

DEPARTMENT OF SCIENCE AND ART OF THE COMMITTEE OF COUNCIL ON EDUCATION, LONDON, S.W.

At South Kensington, the 21st day of August 1895.

BY THE RIGHT HONOURABLE THE LORDS OF THE COMMITTEE OF HER MAJESTY'S MOST HONOURABLE PRIVY COUNCIL ON EDUCATION.

The Lords of the Committee of Council on Education consider the question of grants for instruction in Science and Art with a view to make them depend partly on the attendance of the student and partly on payments on results as tested by examination.

They decide as follows, subject to the sanction of the Lords Commissioners of Her Majesty's Treasury:—

1. The Committees of Science and Art Schools and Classes which have been in the receipt of grants from the Department of Science and Art for two consecutive years, or which are conducted by a local authority under the Technical Instruction Act, 1889, or the Technical Schools (Scotland) Act, 1887, will be allowed to elect to receive their grants on the following scheme, provided that the Inspector of the Department reports that the teaching and equipment of the School are thoroughly satisfactory, and that the class or classes are not too large for instruction by the staff of teachers.

2. The payments on results will be half those on the present scale (§ 14, p. 30, for Science, and § 31, (*a*), (*b*), (*c*), and (*d*), p. 76, for Art), the deductions for previous successes, etc. being varied proportionately.

3. A grant will be made, on the Certificate of the Committee of the School for each attendance of *at least* an hour's duration of a student who has made not less than ten such attendances during the session:—

(*a*) Of 1d. for each attendance in a day Science Class, and 2d. in a night Science Class; and of 3d. for each attendance of 1½ hour's duration given to practical work in Chemistry, Physics, Metallurgy, or Biology, in a properly equipped laboratory. But no more attendances in any one subject of Science will be counted during one session on behalf of any one student than are sufficient to make up an attendance grant of 6s. 8d. or, in the above named practical subjects, of 10s.

(*b*) Of 1d. for each attendance in an Art School or Class; but this payment will be increased to 1½d. for Drawing and Modelling from the Antique, and to 2d. for Drawing and Modelling from the full length Living Model if the students are fully qualified for such instruction, and if the instruction is given in properly lighted studios appropriated for the purpose. But no more than 80 attendances will be counted during one session on behalf of a student in the subjects classed under Group A.

4. The attendance grant will only be made if the student is of the industrial class as defined by the Science and Art Directory, and if the attendance for which the grant is claimed is such as can be legitimately registered under its rules. It will be necessary to keep special registers for the attendances in practical work in Chemistry, Physics, Metallurgy, and Biology; and also for Drawing and Modelling from the Antique and from the Life.

5. The total attendance grant on account of any one student during a session will not exceed £1 10s. for Science, and will not exceed £1 10s. for Art.

6. The attendance grant may be increased 25 per cent. in classes in small towns and villages with a population of less than 5,000, if it appears that the circumstances of the locality are such as to justify the addition to the grant.

7. A day attendance is one which commences before 6 p.m., and an evening attendance one which commences after that hour, except on Saturdays, when an attendance after 2 p.m. may be counted as an evening attendance.

8. Applications to receive grants under this Minute must be received before 1st December 1896; and in subsequent years before 1st November. But the sanction to be so treated may be withdrawn at any time should it appear from the results of the examination in May, or from the reports of the Inspectors, that the instruction is not efficient; and no school can receive grants partly under this Minute and partly under the ordinary scale of payments on results.

9. In order to obtain grants under this Minute, the rules and conditions of the Science and Art Directory must be complied with.

10. Organized Science Schools cannot claim attendance grants under this Minute; nor can these grants be claimed on behalf of students who are on the register of an Elementary School.

By order,
J. F. D. DONNELLY.

MAGNETISM AND ELECTRICITY.

BY EDWIN EDSER, A.R.C.S.
Mathematical Lecturer and Physical Demonstrator South Western Polytechnic, late Assistant in the Physical Laboratory, Royal College of Science.

THE REFLECTING GALVANOMETER.

For most delicate work in electricity the instrument generally used to indicate or measure current is the Reflecting Galvanometer. This consists essentially of an ordinary galvanometer, with a small mirror attached to the suspended system in such a manner that a horizontal beam of light passing through a slit and falling on it will be reflected back on to a graduated horizontal scale placed immediately above slit. The light will now fall practically normally on the mirror, and will consequently be reflected normally from it. If now the mirror rotate about a vertical axis, since the reflected beam is equally inclined to the normal with the incident beam, the former will move over double the angle of rotation of the mirror. This is at once seen from Fig. 1. AB is the horizontal projection of the scale, and a beam of light from a lamp L passes through a narrow slit *s* directly beneath it, falling on the mirror *ab*, which reflects it back on to the scale immediately above the slit. If *ab* be a slightly concave mirror, or, being plane, if a lens be placed in front of it, by properly adjusting the distance, a bright and well-defined image of the slit will be formed. Now suppose the mirror to rotate through an angle θ about a vertical axis to the new position a^1b^1; then *cd*, the normal to the mirror, will now make an angle θ with the incident ray; *cd* will therefore be the position of the reflected beam, making an angle 2θ with the incident beam.

The suspended system when displaced from its position of equilibrium will not generally at once return permanently to that position on the constraining force being removed, but will oscillate about it for some time, the amplitude of the oscillations gradually diminishing till they become imperceptibly small. A moment's consideration will show that the period of these oscillations will have to be kept within certain limits for it to be possible to do any practical work with the instrument; for if they be too short it would be difficult to observe the position of the spot of light at the extremes of its excursion, supposing such an observation to be necessary; whilst if it were too long, an inconveniently long time would have to elapse before the suspended system had reached its position equilibrium, and another experiment commenced. It therefore becomes important at the outset to determine the conditions which control the period of the suspended system, so that we may modify them according to the requirements of the experiment engaged on.

In what follows the term *period* will be applied to the duration of one *complete* oscillation, measured from the time of passing through the position of equilibrium, to the period when it is again passing through that position *in the same direction*.

It is found, experimentally, that when the amplitude of the vibration is small, the displacement of the suspended system

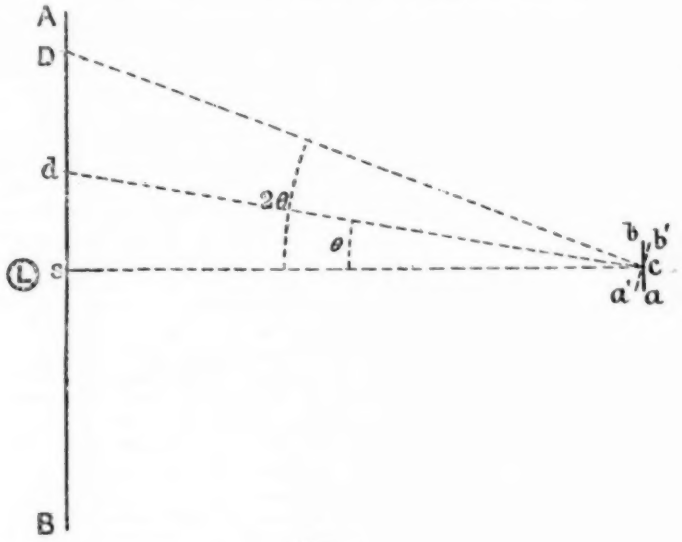


FIG. 1.

varies harmonically with the time. To understand this, let us refer to Fig. 2. Suppose a point to move at an uniform speed around

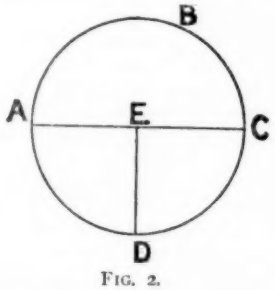


FIG. 2.

the circle ABCD, of radius equal to the amplitude of the displacement, in such a manner that it completes one revolution in T, the period of the suspended system. Then, if at any instant the position of the point be projected on to the horizontal line AC, the distance of the latter position from ED, the centre of the circle, will indicate the displacement of the oscillating system at that instant.

If this diagram be carefully studied it will be seen that the displacement varies rapidly on either side of E, and becomes more and more constant, till at A and C, the ends of the excursion, the displacement is stationary for an instant. Anyone who has worked with a reflecting galvanometer will remember that the spot of light moves at a great velocity when passing in either direction through the zero point; whilst at the end of its swing it is momentarily stationary.

When the suspended system has reached the limit of its swing and is for an instant stationary, it can have no kinetic energy; it has, however, a store of energy of position, or *potential* energy, which will at once show itself by being turned into *kinetic* energy, setting the system once more in motion towards its position of equilibrium. When it has reached the latter point, since there is no force acting on it, it can have no potential energy; the whole of the latter having been converted into kinetic energy, or energy of motion. We can, then, supposing the system to be *conservative* (*i.e.*, that no energy is dissipated by friction or similar processes), equate the potential to the kinetic energy. We will now obtain an expression for each of these in an oscillatory system, taking first the familiar one of a swinging pendulum, and afterwards that of a small magnet suspended in the earth's field.

Let AB be a pendulum, consisting of a massless rigid rod AB, with a heavy particle at B. This will, of course, swing along the arc of a circle having A for centre. Neglecting the friction of the air, we shall have—

Work done in passing from C to B = work done in raising B against gravity = mgh, where

m = mass of particle;
g = force exerted by gravity on unit mass;
h = distance CD = $l(1 - \cos\theta)$, θ being the angle BAC, and l = length AB = AC.

$\therefore$ Potential energy (V) at any point B = $mgl(1 - \cos\theta)$

$$= mgl \times 2\sin^2\frac{\theta}{2}.$$

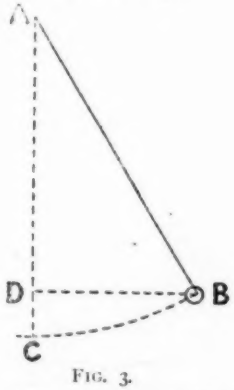


FIG. 3.

Also, if θ be small, $\sin\theta$ may be put $= \theta$ without any appreciable error.

$$\therefore V = \frac{mgl}{2}\theta_1^2.$$

At the end of the swing, let V_1 stand for the potential energy, and θ_1 for the corresponding angular displacement. Then—

$$V_1 = \frac{mgl}{2}\theta_1^2 \ldots\ldots (1).$$

We must now find the kinetic energy at the middle of the swing (*i.e.*, when the pendulum bob is passing through its position of equilibrium).

Referring to Fig. 2, and supposing that the point is revolving in the direction of the arrow, it will be seen that when it has reached D, it will momentarily be moving parallel to the line CA. The velocity of the revolving point and that of its projection will at that instant be equal. Let a = amplitude of vibration = radius of circle

ABCD. Then, if T be the time of one complete revolution (*i.e.* the period of the pendulum),

$$\frac{2\pi a}{T} = \text{velocity at D.}$$

Also, kinetic energy of a moving body $= \frac{1}{2}mv^2$, v being the velocity of the body.

$\therefore$ kinetic energy of body at middle of swing $= E = \frac{1}{2}m\left(\frac{2\pi a}{T}\right)^2$.

Equating this to (1), and observing that a = amplitude $= l\theta_1$, we get—

$$\frac{1}{2}m\frac{(2\pi l\theta_1)^2}{T^2} = \frac{1}{2}mgl\theta_1^2;$$

$$\therefore \frac{(2\pi)^2 l}{T^2} = g;$$

$$\therefore T^2 = (2\pi)^2\frac{l}{g}$$

$$T = 2\pi\sqrt{\frac{l}{g}}.$$

This is the well-known law connecting the time of swing with the length of a simple pendulum at a place where the force of gravity $= g$. The same result may more expeditiously be obtained by a simple application of the Calculus; but even to those who are acquainted with the latter the above reasoning may prove of value, as giving a greater insight into the mechanics of the problem.

Let us now turn to the case of a small suspended magnetic needle displaced from its position of equilibrium (SN Fig. 4) in the earth's

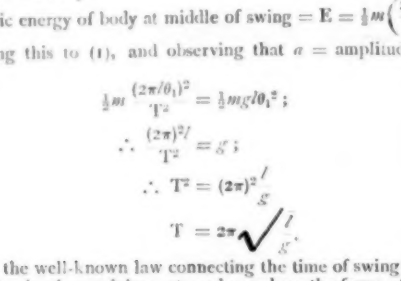


FIG. 4.

field. When the needle has rotated through angle θ to the position ns, the force resolved along the direction of motion of the N pole $= m\text{H}\sin\theta$, where m = pole strength and H = earth's horizontal field; when θ is small, $\sin\theta = \theta$. $\therefore$ Force $= m\text{H}\theta$. If θ_1 now be taken as the angular displacement at the end of the swing, the *average* force during the swing $= \frac{m\text{H}\theta_1}{2}$, since the force varies from zero at NS to $m\text{H}\theta_1$ at the end of swing. Then

Work done during rotation on N pole $= m\text{H}\frac{\theta_1}{2}\times\frac{l}{2}\theta_1$,

l being the length of the magnet.

$\therefore$ Work done on both poles $= 2\times m\text{H}\frac{\theta_1}{2}\times\frac{l}{2}\theta_1$,

$$= \text{MH}\frac{\theta_1^2}{2},$$

where $\text{M} = ml$ = moment of magnet.

$\therefore$ Potential Energy at end of swing $= \text{MH}\frac{\theta_1^2}{2}$.

To obtain the kinetic energy, the whole rotating system, including the mirror, etc., must be taken into account. Let I be the moment of inertia of this system; then kinetic energy $= \frac{1}{2}\text{I}w^2$, where w = angular velocity.

By reasoning similar to that used formerly—

$$w = \frac{2\pi\theta_1}{T};$$

$$\therefore \frac{1}{2}\text{I}\left(\frac{2\pi\theta_1}{T}\right)^2 = \frac{1}{2}\text{MH}\theta_1^2;$$

$$\therefore \text{I}\frac{(2\pi)^2}{T^2} = \text{MH};$$

$$\therefore T = 2\pi\sqrt{\frac{\text{I}}{\text{MH}}}.$$

This equation connects the time of vibration of a galvanometer needle with the moment of inertia of the suspended system, the magnetic moment of the magnet, and the field in which the vibrations take place. To make T long, the value of I may be increased, as is commonly done in ballistic galvanometers; or the value of M or H or both may be decreased. Decreasing H by means of a control magnet has, however, this disadvantage, that any slight variations of the earth's field during the experiment become very prominent, and may therefore alter the sensitiveness of the instrument.

COMING MEN.

XVII.—MR. A. C. BURGESS,

Higher Grade School, Cardiff.

Secretary to the South Wales District Union; Member of the Committee of the Assistants' Federation; Vice-President of the Cardiff Assistants' Association, &c.

To all who follow the work of the N.U.T., and who note the various localities which display exceptional vitality, it would be superfluous to comment on the efficiency which characterises the Union's operations in South Wales. Of late years this particular district has amply demonstrated its appreciation of the Union's services, and Cardiff stands out prominently as a forward and influential association. In 1891 the teachers of Cardiff entertained the Conference of the Union, and the memories of that most successful gathering will dwell long in the minds of the representatives. Since that period Unionism has progressed in South Wales at a rapid rate, and many of the stalwarts of the profession hail from that district. No organisation is conducted with success without a vast amount of labour and self-denial on the part of those who are responsible for its management, and the energy and devotion displayed by the subject of our present sketch call for his inclusion in a series of articles which we may be pardoned for describing as unique in the selection of those who, though not yet veterans, have attained a high position in the educational arena.

One cannot visit any association within the area covered by the South Wales District Union without being impressed with the manner in which Mr. Burgess pervades the neighbourhood.

Of a most unassuming personality, he seems to intuitively grasp the necessities of any situation, and at once proceeds to put into operation the essential machinery for the realisation of a proper condition of affairs. It is undoubtedly to this patient, dogmatic perseverance that he owes his success, and we know full well the calibre of the man who can efficiently conduct the organisation of a large and difficult district.

It was, therefore, with no small degree of pleasure that we sought out Mr. Burgess and endeavoured to elicit from him some facts concerning himself and his labours.

Mr. Burgess was born at Port Talbot, South Wales, in the year 1866. Though not actually a Welshman, he is essentially one by sympathy. He was educated at Margam Copper Works School, which was then carried on by the family of the late Lord Swansea.

After completing his career as a scholar at this establishment, he became a Pupil Teacher at the same school. At the conclusion of his apprenticeship he obtained a position in the First Class at the Queen's Scholarship Examination, and proceeded to the Training College at Cheltenham in 1885.

Commenting on his period of training, Mr. Burgess gave us a rather novel expression of opinion.

'I was far from being enamoured,' he said, 'of College life. In fact, I believe I obtained very little benefit from it, excepting the influence and guidance

of Mr. Baker, M.A., the Superintendent Master. Comparatively speaking, I consider it a waste of two of the best years of my life.'

On leaving Cheltenham Mr. Burgess returned home to take charge of the National School. He, however, thought that private teaching would be more congenial, and therefore accepted a position at Henley-on-Thames. Mr. Burgess appears to have discovered that this mode of life had disadvantages far more potent than he had anticipated, and after a brief stay at Henley he undertook an appointment as Class Teacher at Earl Dudley's School at Dudley. In 1889 he was appointed to the Cardiff Higher Grade School. In 1892 he was promoted to the Science Department of this school, and is now engaged in teaching the Second Year's Course under the new Organised Science School regulations.

Since leaving College Mr. Burgess has matriculated and obtained his Intermediate B.A. degree at the London University.

In conjunction with the majority of our 'Coming Men,' Mr. Burgess was introduced to the active work of the Union through the medium of an Assistant Teachers' Association. He joined the Union soon after leaving College, but it was so recently as 1892 that he became an active agent. In that year the Cardiff Assistant Teachers' Association was formed, and Mr. Burgess was elected to the Committee of that body. His work in connection with this organisation brought him before the notice of the local branch of the N.U.T., with the result that he was elected to the Committee of that Association. Since that time he has taken great interest in matters concerning the Union. His influence has been exerted and he has filled various offices to the satisfaction of his colleagues, and this year he was elected to the responsible position of Secretary of the South Wales District Union. He represented the Cardiff Association at the Oxford and Manchester Conferences of the Union, and the Bridgend Association deputed him to act as their representative at the latter gathering. At the Birmingham Conference of last year he represented the Cardiff Assistant Teachers' Association. He was successful at this Conference in being elected to the Committee of the National Federation of Assistant Teachers.

Yours faithfully
Alfred C. Burgess.

Mr. Burgess was the first Class Teacher in South Wales to agitate against the claims of the Certificated Class Teachers being ignored in the Charter of the University of Wales and in the Supplemental Charter of the University College of South Wales and Monmouthshire. Speaking on this subject, Mr. Burgess said: "I recognised to the full the advance made when the Privy Council allowed representatives of the teachers in elementary schools to sit on the governing bodies of these institutions, but I was extremely disappointed to find that the head teachers alone had the right to nominate and elect these representatives. By constantly airing our grievances at the meetings of the Local Association and District Union, and claiming that the certificate, and not accident and position, should be the basis of exercising the franchise in such elections, the state of affairs has been much improved.'

A further conversation on this matter informed us that Mr. Burgess holds some very pronounced opinions on the question. He stated that deputations have been sent to the proper quarter, with the result that the claim of the Certificated Class Teacher has been recognised by the governing body of the University College of South Wales, and most sympathetically listened to at the last meeting of the Court of the University of Wales.

He said: 'I am of opinion that the agitation then conducted was the cause of the certificate being recognised as the basis in the election of representatives on the Central Board of the Welsh Intermediate Education Scheme. I may further add that I am very much dissatisfied with the position of the Class Teacher under the Welsh Intermediate Scheme, and have more than once spoken of his insecurity of tenure. The scholars are even more protected than the teacher.'

Mr. Burgess condemns in strong terms the resolution passed at the late Conference of Head Teachers of Intermediate Schools, asking that the appointment and dismissal of the assistants should be left in the hands of the head teacher.

Replying to a query respecting the results obtained from the Science and Art Department, Mr. Burgess observed: 'As a teacher in an Organised Science

School and in a Technical School, I think that the Department should give certificates for any pass in science, as it is most discouraging for a young scholar or workman to receive no recognition of his work when he fails to come up to the high standard now required by the Department to obtain a pass. I do not believe in payment of grant on all passes, and I am of opinion that the present system has prevented students being sent in on the off chance of scoring a success, and has resulted in science being taught in a more intelligent manner.'

We had some conversation on the comparative requirements demanded from teachers in Organised Science Schools and in Technical Schools. We cordially endorsed the opinion of Mr. Burgess when he remarked: 'I do not see why the Science and Art Department should insist on teachers in Organised Science Schools holding at least an advanced First Class Certificate in any subject they propose to teach, while they require nothing at all from a teacher in a Technical School. It seems to me the height of absurdity that I can teach a subject in a Technical School in one street and yet am not allowed to do so in an Organised Science School in the next. But then the ways of the Department were always peculiar.'

Mr. Burgess finds serious fault with the Day Training College system. He contends that the residential student is at a serious disadvantage, and will be so until the examinations are independent of the college authorities and held by persons having no connection with the colleges. The revision of the list three or four times before it is accepted by the college authorities cannot help but make the residential student discontented, and tend to keep students from the residential colleges. Moreover, the manner in which some of the examinations are conducted must have a serious influence upon the students. Mr. Burgess thinks that the time has long since passed when the Executive of the Union should have looked closely into this matter and endeavoured to protect the resident student. As the system now stands, he considers it to be a miserable fraud.

We have already referred to the position Mr. Burgess holds in connection with his District Union. In addition, he acts as Press and Parliamentary Secretary to the Cardiff Teachers' Association. He is also Chairman of the local branch of the Teachers' Provident Society. He also occupies the Vice-Presidency of the Cardiff Assistant Teachers' Association. His interest in the higher branches of education is very great, as is evidenced by his expressions of opinion which we have set forth. As a Unionist, he favours a forward policy. He has not long been in the arena, but he has already given ample promise of what we may expect from him.

He has the advantage of a district which affords abundant scope for his energies, and we confidently look forward to a considerable development of the Union's forces and an extension of its policy as the outcome of his efforts.

As a class teacher he is of a thorough representative character, and has won for himself the confidence and respect of his fellows. As an educationist he has set before himself a high ideal, and one cannot fail to be impressed with the earnestness of his convictions. A fearless advocacy of what he feels to be just, a strong determination to press forward the claims of education, and an ability to champion the cause of the wronged, are his chief characteristics, and, with these qualifications, it will be strange indeed if he does not make good the prophecy that we have indulged in by placing him where we think he has every claim to a position—among the ranks of our 'Coming Men.'

PITMAN'S METROPOLITAN SCHOOL.—The annual meeting of the above will be held on Tuesday, October 29th, at the Holborn Town Hall, Gray's Inn Road, W.C., at 7.30 p.m., when the various money prizes, medals, and first-class certificates won by members of the school at the Society of Arts and other examinations during 1895, will be presented by the Attorney-General, Sir Richard Webster, G.C.M.G., Q.C., M.P. The chair will be taken by J. R. Diggle, Esq., M.A., J.P. (late Chairman London School Board). The distribution will be followed by a concert. Admission free, by ticket only, to be obtained on application to the Manager, Pitman's Metropolitan School, 27, Chancery Lane, W.C.; or to Sir Isaac Pitman & Sons, 1, Amen Corner, E.C.

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GREGORY'S ELEMENTARY PHYSIOGRAPHY.

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NOTES ON PHYSIOLOGY,

EMBRACING THE SUBJECTS OF THE ADVANCED AND HONOURS STAGES, SCIENCE AND ART DEPARTMENT.

BY WALKER OVEREND, M.A., M.D. (OXON.), B.SC. (LOND.),
Late Radcliffe Fellow, Scholar of Balliol College, and Exhibitioner in Comp. Anatomy of the London University.

1. In this monthly series of papers, the subjects of the Advanced Stage will be fully treated. Hints to candidates intending to take up Honours will be given, with specimens of answers and directions for practical work. We shall commence with Sections L and M of the Syllabus, that is the Nervous System and Reproduction.

2. *The Central Nervous System.*—The student should peruse, in the first place, chapter xii. of the author's 'Elements of Human Physiology' (published by Hughes), also paragraphs 49 and 50, pages 48 and 49. Having carefully and fully mastered this chapter, the student may proceed to further details. In the diagram of the Spinal Cord it is obvious

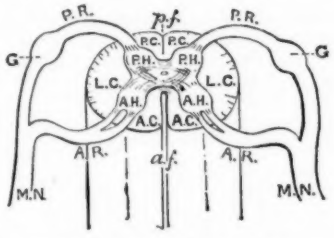

Fig. 100. A diagram of the spinal cord; *a.f.*, anterior fissure; *p.f.*, posterior fissure. P.R., posterior root; G, ganglion or swelling on the posterior root; A.R., anterior root; M.N., the mixed nerve, or spinal nerve. The white matter is divided on each side into P.C., posterior columns; L.C., lateral columns; A.C., anterior columns. The gray matter, into P.H., posterior horns, and A.H., anterior horns, with a median portion uniting the two.

that the exits of the nerves divide the spinal cord into three principal portions—an anterior, posterior, and lateral column. The *white matter* consists of medullated nerve fibres, which chiefly run in a longitudinal direction. The *grey matter* also contains medullated nerve fibres, but these are much finer. Also, scattered throughout and in groups, the grey matter possesses, in addition, nerve cells with branching processes, and these branches, continually dividing and subdividing, finally communicate with those belonging to neighbouring nerve cells. So that a very fine network or *reticulum* of fibres is produced. Each nerve-cell, by one of its branches at least, communicates with one axis-cylinder. The delicate connective tissue which surrounds the fibres and cells and forms the part of a supporting framework is termed *neuroglia*.

The nerve cells of the anterior horns are large, and each possesses a process which becomes an axis-cylinder and passes out in the anterior nerve-roots as a motor nerve-fibre. The cells of the posterior horns are less in size and fewer in number. There is one important group of nerve-cells which lies between the letters PH and PC. These cells form a column, and they lie with their long axes parallel to the spinal cord itself. It is termed the *vesicular* column, inasmuch as it is connected with the nerves which supply the blood-vessels generally and the viscera of the thorax and abdomen.

3. *Bell's Law.*—The anterior roots of the spinal nerves are motor, or efferent. The posterior are sensory, or afferent. In other words, the nerve-fibres in the latter carry impulses from the skin, muscles, and viscera towards the spinal cord. The anterior roots, on the other hand, carry nerves which transmit impulses from the spinal cord to the periphery. This generalisation is termed Bell's Law, since Sir Charles Bell first established the facts. The evidence is stated in paragraph 176 of the 'Elements of Physiology,' already referred to above. There is, however, one exception to the law, and that is, in the higher animals (Mammalia), when the anterior roots are cut, signs of pain manifest themselves. The explanation is that some of the sensory fibres of the posterior roots run up in the anterior to supply the *pia mater* of the spinal cord. This circumstance is called the *recurrent sensibility* of the anterior roots.

4. The spinal cord is a great centre for reflex action. When a frog is deprived of its brain, including the medulla oblongata, the animal is

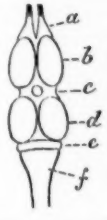

Fig. 109. The brain of the frog. *a*, olfactory lobes; *b*, cerebral hemispheres; *c*, optic thalamus; *d*, optic lobes; *e*, cerebellum; *f*, medulla oblongata.

still capable of performing certain co-ordinated and apparently *purposive* movements, and this, obviously, in the absence of *consciousness*. Such movements are termed reflex actions. In paragraph 177 of the Author's text-book these phenomena are described, with the essential requirements necessary to carry them out. Many such reflex actions occur in connection with the spinal cord. The higher centres, also, take part in similar movements; although, in these instances, consciousness may participate, still the latter is dispensable. Moreover, reflex actions are more lively, and more easily induced when the higher centres are asleep. Thus coughing—a reflex act—may be to some extent controlled by the will. The movements of swallowing are quite easily performed in the absence of consciousness, during sleep, or when a man is under the influence of alcohol. The contraction of the pupil of the eye, which follows when a bright light falls upon it, of sneezing, hiccough, and the secretion of saliva are common examples of reflex actions.

5. *Co-ordinated* reflexes are characterised by the number of muscles brought into play, and by the fact that these muscles combine for some definite and generally useful purpose. Reflexes which are not co-ordinated (that is, inco-ordinated) or convulsions, on the other hand, are exhibited under certain unhealthy and abnormal conditions of the nervous system.

When a frog is poisoned by means of a minute dose of strychnine ($\frac{1}{4000}$ of a gramme), the least touch, a breath of air, a slight shake of the table, is sufficient to send the whole body into convulsions, and this follows if the frog be killed first and the strychnine placed on the spinal cord itself. Obviously, this drug has an enormous influence on the spinal cord. In a converse manner, if a small crystal of common salt be placed on the optic lobes of a frog's brain (*see* diagram), reflexes are then much more difficult of performance. The frog, for instance, may fail to lift his leg out of a dilute solution of acetic acid, or the interval may be ten times that of the usual time. This is termed *Inhibition* of reflex action, and is similar to that possessed by the will. Similarly, if a stimulus from another part of the body reaches the spinal cord at the same time, an interference takes place, and the reflex time is prolonged, or the movement may be altogether annulled.

6. *Muscular Tone.*—The muscles of the body are normally slightly stretched—that is, in a condition of *tonus*. During sleep the muscles preserve this condition, for there is a marked contrast, in the aspect, between the condition of sleep and that of death. Our muscles, in fact, as long as the body is in a normal condition, even during sleep, are to some extent in a state of activity, and so contracted as to balance each other's actions. This tone is dependent on the nervous system. In a frog, when the posterior roots connected with one leg are divided, this leg hangs more loosely than the other. The muscles are, therefore, kept in this slight condition of tonicity by impulses passing to the spinal cord from the skin along the posterior roots, and thence reflected by way of the anterior roots to the muscles. Other examples of reflex action are seen in micturition and parturition, and the centres lie in the lower or lumbar part of the spinal cord.

7. *The Spinal Cord as a Conductor of Nerve Impulses.*—In addition to its importance as a great centre of reflex activity, the spinal cord conducts impulses from the limbs, viscera, and skin towards the brain, and *vice versâ*. Now, by various methods of experimentation it has been demonstrated that these impulses do not run in a scattered or indiscriminate manner through the cord, but they are collected into certain regions. For instance, *sensations of touch* are carried in the *posterior columns*, those of *pain* and *temperature* in the lateral columns. *Sensory* impulses from one side of the body, say the left, ascend in the spinal cord on the *same* side, that is the left, and when they reach the medulla oblongata they cross to the opposite half of the brain. This statement is opposed to that of Brown-Séquard, for it is only during the last few years that it has been satisfactorily and indubitably demonstrated that sensory impulses, as far as the spinal cord is concerned, keep to their own side after entering it.

Motor impulses coming from the brain also cross in the medulla oblongata to run down the opposite half of the spinal cord. An injury or section affecting one half of the spinal cord (that is, a *hemi-section*) in the middle of the body is followed by paralysis of movement and impaired sense of feeling on the same side below the injury.

Certain other tracts or bundles of fibres must be mentioned. There is one on the outside of the cord, the fibres of which proceed to the cerebellum, and form a connection between it and the muscles of the legs and arms. It is termed the *cerebellar* tract, and, as we shall see later, is useful in the maintenance of equilibrium necessary for the proper performance of such movements as walking, standing, jumping, and running. In the next paper we shall complete the account of the Nervous System and Reproduction.

(*To be continued.*)

OUR PUPIL TEACHERS' AND SCHOLARSHIP COURSE.

BY ARTHUR T. FLUX,

Head Master of the Belvedere Pupil Teachers' Centre, First on Scholarship List, Author of 'Scholarship School Management.'

PUPIL TEACHERS' COURSE.

SCHEME OF WORK FOR THE MONTH.

WORK TO BE PREPARED.

A.—*English.*

First Year.

1. The definitions of the various terms relating to the noun. Attend particularly to Classification and Case.
2. The Anglo-Saxon suffixes and the meanings:
   Adjectives—*-ed, d, -en, -n, -ern, -fast, -faced, -fold, -ful, -ish, -less, -some, -ward, -wise.*
   Verbs—*-el, -er, -en, -k, -se.*
3. Principal and Subordinate Sentences.
4. Learn ten Roots and meanings per week.

Second Year.

1. The Verb. Classification as Regular and Irregular, Transitive and Intransitive, Weak and Strong, Impersonal, Neuter, etc.
   Voice, Moods, Tense, Number and Person.
   Chief points to be noticed:—(1) Perfect and Complete Definitions of each term; Impersonal Verbs; Voice, Active and Passive; the Moods, especially the Subjunctive. Tense: Adopt the Classification—

Present Imperfect	I write.
Present Perfect -	I have written.
Past Imperfect -	I wrote.
Past Perfect -	I had written.
Future Imperfect	I shall write.
Future Perfect -	I shall have written.

   Note that the Perfect Tenses are formed by the use of *have* or *had*. Some grammarians add an additional form to each, the Progressive; *e.g.*, I am writing = Present Progressive tense.
2. One quarter of the Latin Prefixes.
3. Learn 15 Roots and meanings each week.

Third Year.

1. English Literature. The chief writers and their works from 1066 to 1485. Note especially Chaucer and his influence in forming a standard English.
   This must be carefully prepared, the authors' style, works, and sketch of their life entered into a note book.
2. Learn 20 Roots and meanings each week.

B.—*Arithmetic.*

First Year (*Boys*).
Lock. Work Examples XXXV.–XXXVII.
Prepare thoroughly the Theory of G.C.M. and L.C.M. and the proofs of the rules.
Girls.—'Girls' Arithmetic.' Work Ex. VIII. (Compound Practice).

Second Year.
Boys.—Lock. Work Exs. LVI.—LVIII.
Girls.—'Girls' Arithmetic.' Work Exs. XIV. and XV.

Third Year.
Boys.—Lock. Work Exs. CXXIV.–CXXVI. Be particularly careful with Discount.
Girls.—'Girls' Arithmetic': Division of Decimals.

C.—*Music.*

First Year.—The Standard Scale of Pitch. Mental effects and how modified.

Second Year.—Continue practice on First Removes of Key.

Third Year.—The Chromatic Notes, their names, uses, etc.

D.—*Spelling.*

Learn 200 words from 'Words Commonly Misspelt' (1st Series), or any good list. Test frequently by dictation.

E.—*Geography.*

Prepare the following countries—France, Spain, Holland, and Belgium.—Chief points:—

FRANCE.—Position, Extent, etc., Coast-line.

Mountains.—Cevennes, Jura, Vosges, Auvergne, Puy de Dome, etc.

Rivers.—Somme, Seine (tributaries: Marne, Aube, Oise, Aisne, Yonne, Euse), Loire (Allier, Cher, Indre, Vienne, and Sarthe), Dordogne, Garonne, Adour, Rhone (Saone, Isère, Durance). Be prepared to describe the basin and course of Rhone—a favourite question.

Climate.—North and west, temperate and moist. Central plateau, greater extremes, hotter in summer, colder in winter. South, warm, temperate. Note.—The Mistral, a strong, cold wind from the central plateau.

Productions—

(*a*) Vegetable.—Olive (for oil), mulberry (for silkworm), maize, orange, citron, apricot, fig, almond, and peach; tobacco. Flax, hemp, wheat, barley, oats, beetroot (for sugar), apples (Normandy cider), forest trees.

(*b*) Animals.—Wolf and wild boar in forests. Common domestic animals; oyster, tunny, anchovy.

(*c*) Mineral.—Coal in north, near Valenciennes, and in centre round St. Etienne.

Iron, Ardennes and Cevennes.

Lead, silver, tin, manganese, in small quantities.

Salt and kaolin (for pottery).

Industries—

(*a*) Agriculture.—France is essentially an agricultural country, 18,000,000 of the inhabitants being engaged in it. The land is much more subdivided than in England. The chief objects of culture are given above. Wine-making is important.

(*b*) Manufactures.—Silk, cotton, and woollen goods are largely made. The first in and round Lyons, the two latter on the Northern Coalfield, Amiens, Lille, Valenciennes, Cambrai, Rouen, etc. Wine, sugar, etc.

(*c*) Mining.

(*d*) Leather tanning, and manufactures at Grenoble and Paris.

(*e*) Fisheries in North Sea, Channel, and Mediterranean.

(*f*) France also produces an immense amount of fancy goods, made mainly at Paris; gloves, jewellery, lace, etc.

(*g*) Shipbuilding at Brest, Havre, Bordeaux, Marseilles, and Toulon.

Political, Commercial, Colonies, etc.—

(*a*) Exports.—Woollen goods, wine, silk, leather, fancy goods, cotton goods, cheese, butter, linen, spirits, sugar (beetroot).

(*b*) Imports.—Wine, wheat, raw silk, timber, raw cotton, hides, coffee, and other colonial produce.

(*c*) Government.—A republican government since 1870; universal suffrage; every man over 21 can vote. The head of the government is the President, elected for seven years. The Senate, 300 members, are elected for nine years, 100 retiring every three years. The Chamber of Deputies (584) elected for four years.

(*d*) Towns.—Paris, population 2,000,000, centre of civilisation and fashion, surrounded by fortifications. Trade in jewellery, bronzes, watches, trinkets, gloves, etc. Chief sights: Notre Dame (cathedral), Madeleine (church), Pantheon, Hôtel des Invalides, Louvre, Palais Royal, Bourse, the Boulevards, etc. In the vicinity, Versailles (palace built by Louis XIV.) Sèvres (china and porcelain).

Calais (packet station), Boulogne and Dieppe (fishing ports), Havre (trade with America), Rouen (Manchester of France), Cherbourg (naval station), Brest, Nantes (cotton and woollen), La Rochelle, Rochfort, Bordeaux (great trade in wine), Bayonne, Marseilles, Toulon, Cannes, Nice, Monaco, Mentone, Chalons, Rheims, Orleans, Tours, Angers, Toulouse, Dijon, Besançon, Lyons, Avignon, Nimes, Grenoble, St. Etienne, Amiens, Lille, Cambrai, Valenciennes.

Education.—Compulsory and free.

Draw a map. Insert all places, and underneath enter anything to be remembered.

HOLLAND.—Name = Hollow Land, consisting of low alluvial land which has been brought down by the Rhine. Much of it lies below the level of the sea; hence the necessity for the huge dykes which have been constructed, at enormous cost, to keep the ocean out, and the system of canals into which the surface drainage water is lifted by means of windmills.

The only large opening, the Zuyder Zee, was formed in the 13th century by the breaking down of some dykes. There is a scheme on foot to reclaim it again. Note the islands at the mouth of the Rhine, Maas, and Schelde, and the line of islands marking the original coast line at the mouth of the Zuyder Zee.

Relief.—The country is one vast plain, crossed by the various mouths of the Rhine (Yssel, Vecht, Lek, and Waal) and the Maas. Canals, of all sizes, take the place of roads, from the North Holland Ship Canal to those which a boy can leap.

Productions:—

Minerals.—As might be expected—none.

Vegetable.—Such articles as will grow in a damp and foggy climate: barley, potatoes, beetroot, oats, rye, madder, Dutch bulbs (hyacinth, tulip, etc.).

Animal.—Dairy produce. Storks protected, since they keep down the number of worms, frogs, etc.

Industries:—Agriculture, dairy farming and cattle rearing, fishing, distilling, paper-making, and horticulture.

Towns—(To be entered in a map and carefully learnt):—

Amsterdam, Rotterdam, Dort, Middleburg, Flushing, Utrecht, Leyden, Arnhem, Haarlem, The Hague (seat of Government), Delft, Schiedam, Luxemburg.

Government.—Constitutional monarchy.

Religion.—Protestant and Roman Catholic.

Character.—The Dutch have always been expert seamen and navigators, having for many years contested the supremacy of the sea with the English. They are particularly clean, frugal, and methodical. The couplet—

> In matters of commerce the fault of the Dutch
> Is giving too little and asking too much—

is hardly correct, but they are certainly keen after a bargain, and amongst the most enterprising traders in Europe. Their foreign possessions (Sumatra, Java, Banca, Borneo, Celebes, The Moluccas, Guiana, etc.) provide them with tropical produce and spices, and they are the spice merchants of Europe.

The heroic stand they made against the Spanish in the time of Elizabeth is indicative of their character.

BELGIUM.—(The land of the Belgæ.) Generally low-lying, rising to hills in the south-east. Watered by the Meuse, Ourthe, and Schelde.

Climate.—As in Holland, damp and foggy.

Productions:—

Minerals.—Coal and iron (in large quantities), zinc, sulphide of iron, clay, and slate.

Vegetable.—Forest (Ardennes and Soignées), wheat, oats, rye, flax, beetroot, and vine.

Animal.—Swine, sheep, and horses (Flemish horses, famous for strength).

Industries:—

1. Manufactures.—Iron and steel goods and cutlery, linen, lace, carpets, porcelain, and sugar.
2. Fishing.
3. Agriculture.

Religion.—Roman Catholic.

Education.—General. Four Universities, Ghent, Liège, Brussels, and Louvain.

Government.—Limited monarchy—King, Senate, and Chamber of Representatives.

Towns.—Many and important. 'This is only one great town':—

Brussels (480,000).—A miniature Paris. Cotton, woollen goods, lace, muslin, and carpets.

Antwerp (220,000).—Busy port. Famous cathedral.

Ostend.—Port and packet station. Seaside resort. Oysters, rabbits, fishing.

Charleroi.—Iron, glass, and chemicals.

Namur.—Iron, glass, chemicals, hardware, and cutlery.

Liège.—Firearms, cannon, machinery.
Verviers.—Woollen stuffs, cloth, flannel.
Mons, Tournai, Ghent (cotton and linen), Bruges (lace—famous belfry), Louvain, Mechlin.

SPAIN AND PORTUGAL.—Physical features and islands. These must be carefully entered into a map and learnt.

Mountains—in five systems :—
(*a*) Cantabrian Mountains, or Mountains of Asturias.
(*b*) Mountains of Castile (Sierra d'Estrella, Sierra de Gredos, Sierra de Guadarrama).
(*c*) Mountains of Toledo.
(*d*) Sierra Morena.
(*e*) Sierra Nevada (Mulhacen highest point).

Rivers.—Valueless for navigation, upper courses too swift, mouths impeded by bars. Minho, Douro, Tagus, Guadiana, Guadalquivir, Segura, Iucar, Guadalaviar, and Ebro.

Climate.—Near southern coast, warm, temperate. On the central plateau, one of extremes, intensely hot in summer, and the reverse in winter.

Productions :—
(*a*) Mineral.—Lead (at Linares), copper (Huelva), coal (Asturias and Leon), silver (Sierra Morena), iron (near Bilbao, in N.), manganese, tin, quicksilver (Almaden), gold, and petroleum.
(*b*) Vegetable.—Wheat, maize, esparto grass (used in making paper), rice, olive, orange, cotton, sugar, nuts, etc., vine, and cork.
(*c*) Animal.—Bear, lynx, fox, wolf, wild boar, and wild oxen.
Merino sheep, camel, mule, cattle, and apes (on Rock of Gibraltar, the only place in Europe where found).

Industries.—Agriculture, wine-making, mining, and fishing (tunny, anchovy, and sardine).

Towns.—The position of, and a few particulars about, each of the following should be known. A map should be drawn, and places inserted :—
Spain.—Madrid, Burgos, Valladolid, Saragossa, Salamanca, Toledo, Badajos, Cordova, Seville, Xeres, Granada (old Moorish capital), Murcia.
Ports :—S. Sebastian, Santander, Ferrol, Corunna, Vigo, Palos, Cadiz, Malaga, Almeria, Carthagena, Alicant, Valencia, Barcelona.
Portugal.—Oporto (port wine), Coimbra, Lisbon, Setubal, and Lagos.

Governments.—Both limited monarchies.

F.—*History.*

Henry IV. and Henry V.

Henry IV.—1399–1413.

Chief points :—
(*a*) Descent and claims to the throne.
(*b*) Revolts against Henry.
1. Plot by Earls of Huntingdon, Kent, Salisbury.
2. 1400.—Revolt of Wales under Owen Glyndwr, who was joined by the Percies.
3. 1407.—Revolt in the North, under Percy, Northumberland, and Scrope, Archbishop of York.
4. 1408.—Last rising of the Earl of Northumberland. Defeat and death at Bramham Moor.
(*c*) Growth of the power of Parliament.
(*d*) The dawn of the Reformation.
The laziness, gluttony, and hypocrisy of the Church of Rome had excited the indignation of many English writers—notably Langland, in 'Piers Plowman'—but it was reserved to Wycliffe to commence the long struggle, which can hardly be said to have finished till 1689. John Wycliffe was born in 1324, in Yorkshire, educated at Harrow and Oxford, became Professor of Divinity at Oxford, and a Royal Chaplain. 1375—Rector of Lutterworth, in Leicestershire. In 1377 charged before Convocation with heresy, and only saved by the election of *two* Popes, 1378—a circumstance which enfeebled the Papal power in England. In 1381 he translated the Scriptures, and attacked the doctrine of Transubstantiation. Died 1384.
Tenets.—Opposed to endowments, approved of marriage of priests, declared against images, auricular confession, indulgences, and monastic vows.

Causes of Wycliffe's success :—
1. The great schism in the Papacy (1378–1414), when there were two Popes, one in Rome and one in Avignon, in France, each asserting his own infallibility, and excommunicating his rival.
2. The opposition which Rome excited by the obstinate enforcement of her claims to supremacy.
3. The zeal and activity with which Wycliffe's poor priests opposed the vices of the regular clergy.
4. Above all, his translation of the Bible, and the effect its reading had on the people.

The Lollards.
Name derived from—
1. *Lolium* = *tares* ; applied by the Prelates.
2. *Lollen* = *to sing* ; from their custom of Psalm singing.
3. Walter Lolhard, a reformer, burnt at Cologne in 1322.
The Lollards denied the efficacy of the Seven Sacraments, rejected Saints' and the Lord's Day, and in other matters agreed with Wycliffe.

Persecution of the Lollards.
The Statute 'De Heretico Comburendo' was passed at the petition of the prelates and clergy in 1401. In Henry IV.'s reign two—Sawtre and Bradley—were burnt, and William Thorpe narrowly escaped in 1407. In 1409 the House of Lords petitioned the King for fresh enactments against the Lollards, which shows that the severe Statute of 1401 had not been sufficient to silence the Reformers. The leader of them, Sir John Oldcastle, Lord Cobham, was imprisoned in the Tower, escaped, fled to Wales, but was taken and burnt in 1417. The chief prosecutor was Chicheley, the Primate, who built the Lollards' Tower in Lambeth Palace.

Henry V.
Chief points :—
(*a*) Home Policy.—New Act against Lollards. Introduction of Legislation by Bills.
(*b*) French War.
First Invasion, 1414–15. Battle of Agincourt.
Second Invasion, 1417–19. The Burgundy party assisted Henry to conquer the whole country. 1420, Treaty of Troyes.
Third Invasion and Death, 1422.

G.—*Euclid.*

Second Year.—Propositions 1–6, Book I.

Third Year.—Book I., Propositions 29, 30, 31, and 32, with two deductions per week.

H.—*Algebra.*

Third Year.—Read Chapters 5–7, and work all examples thereon, of 'Scholarship Algebra.'

I.—*Teaching.*

Second Year.—The qualities of Good Reading. Common Mistakes, and their correction. ('Scholarship School Management.')

Third Year.—The teaching of Geography.
Test reading by means of questions at the end of the book.

TEST QUESTIONS.

1. *Penmanship.*—Write as specimens of—
Large-hand :—Biography, Cyclostyle, Dicotyledon, Diphragm.
Small-hand :—'The old order changeth, yielding place to new.'
(If this subject is at all weak, daily practice must be taken from a good copy-book. It is very important, and with many P.T's a very weak point.)

2. Write an essay each week, selecting from the following topics :— .
(*a*) Singing Birds ; (*b*) Fairy Tales ; (*c*) Emigration ; (*d*) The advantages of a good Education ; (*e*) Good Habits ; (*f*) Modes of Travel.

3. *Notes of Lesson.*
First Year Pupil Teachers should work outline notes ; Second and Third Years full notes :—
(1) A Fish ; (2) Insects ; (3) Coal ; (4) Cotton and its Manufactures ; (5) Mouse ; (6) Autumn ; (7) Bird's Nest ; (8) The Milkman (Infants).

(N.B.—A criticism lesson should be given once a week, and the points, good and bad, carefully noted in one of the many books for that purpose published.)

4. *First Year.*

(*a*) Define Adverb, Conjunction, Interjection, and Grammar.

(*b*) Explain the force of the suffix in the following words :— Wooden, maiden, written, brighten, children, hapless.

(*c*) Analyse the following passages, and parse the words in italics :—

(i.) *There was* a sound of revelry *by night*,
And Belgium's capital had gathered *there*
Her beauty and her *chivalry*.

(ii.) When we *had visited* the house *where* my father was born, my father and I went *to visit* an old *friend* of *his*.

(iii.) *When* the order *to charge* was given, there was a sudden silence, and the face of *each* man assumed an expression *which* boded *but little good* to the enemy.

Second Year.

(*a*) Give all the forms of the Prefix *Ad* which you can, with examples. Why does the *d* change?

(*b*) Define Nominative Absolute and Adverbial Object, and give three examples of each.

(*c*) Paraphrase and analyse the following passages, and parse the words in italics :—

(i.) I looked upon his brow ; *no* sign
Of guilt or fear was there.
He stood *as* proud by that death shrine
As even o'er despair.
He had a power ; in his eye
There was a quenchless energy,
A *spirit* that could dare
The deadliest form that death could take,
And *dare* it for the *daring's* sake.

(ii.) *Not far* advanced was morning day,
When Marmion *did* his troop array
To Surrey's camp *to ride*.
He had safe-conduct for his band
Beneath the Royal Seal and hand,
And Douglas gave a guide.
The train *from out the castle* drew,
But Marmion stopped *to bid adieu*.

Third Year.

(*a*) What do you know of Caedmon?

(*b*) In what respects did the Anglo-Saxon language mainly differ from modern English?

(*c*) Paraphrase and analyse the following, and parse words in italics :—

(i.) *Not free* from *boding* thoughts, *awhile*
The shepherd stood ; then makes his way
O'er rocks and stones, *following* the dog
As quickly *as he may*.
Not far had gone before he found
A human skeleton on the ground.
The appalled discover with a sigh,
Looks round *to learn* the history.

(ii.) A light broke *in upon* my brain,
It was the carol of a bird.
It ceased, and then it came again,
The *sweetest song* ear *ever* heard.
And *mine* was thankful *till* my eyes
Ran over with the glad surprise,
And they *that* moment could not see
I was the mate of *misery*.

5. Give some account of the legal reforms of Edward III.'s reign.

6. Explain clearly the causes which led to the Hundred Years' War, and give the chief events in it.

7. Say what you can of the state of the peasantry in Richard II.'s reign.

8. What are the chief plains of Europe?

9. Give some reasons why Europe should be the most important of the Continents. What classes of people are found there?

10. What volcanoes are found in Europe? Give an account of one.

11. Name the following intervals.

$\left\{\begin{matrix}l\\d,\end{matrix}\right.$ $\left\{\begin{matrix}t\\m\end{matrix}\right.$ $\left\{\begin{matrix}r\\l,\end{matrix}\right.$ $\left\{\begin{matrix}f\\t,\end{matrix}\right.$ $\left\{\begin{matrix}t\\f\end{matrix}\right.$ $\left\{\begin{matrix}r'\\d\end{matrix}\right.$

12. *Third Year.*—Explain the construction of the minor scale. Give the three forms. What do you mean by 'Ray Mode'?

SCHOLARSHIP COURSE FOR DECEMBER, 1895.

Work for the Month.

Reading and Copy-setting.—A few minutes' practice at each should be taken every day.

1. *Spelling.*

250 words from 'Words commonly Misspelt,' or any good list.

Practice writing from Dictation at least once a week from now till the Examination. Passages may be selected from Macaulay, Thackeray, etc.—any good classical writer.

2. *Composition.*

Write one or two essays each week, selecting the subjects from the following :—

(1) Insect life.
(2) The pleasures and uses of a garden.
(3) The use and abuse of stimulants.
(4) The advantages and disadvantages of solitude.
(5) The advantages of a good memory.
(6) An April day.
(7) Changes in modern life caused by railways and telegraphs.
(8) Knowledge is power.
(9) Life-boats and their services.
(10) The reign of Queen Elizabeth.

(An essay should be sent in occasionally for examination and criticism. Too much attention cannot be given to composition, as it affects all papers.)

Draft an analysis of each essay before writing, and enter in a note-book. Read up the subject if necessary, but do not consult any books or notes while writing.

3. *English.*

(1) Analyse the following extracts, and parse the words in italics :—

(*a*) There is a perennial nobleness, *and even* sacredness, in work. *Were he never so* benighted, forgetful of his high calling, there is always hope in a man that actually and earnestly works ; in idleness *alone* is there perpetual despair. Work *never so* mammonish, so mean, is in communication with nature ; the real desire *to get* work *done* will itself lead one *more and more* to truth, to nature's appointments and regulations, which are truth. The latest gospel in this world is 'know thy work, and do it.'

(*b*) *When* we met with the incident, *or* heard the conversation, or saw the spectacle which were the first causes or occasions of *some* of the chief permanent tendencies of future life, *how little* could we think that *long* afterwards we might be curiously and *in vain* desirous to investigate those tendencies back to their origin.

(*c*) In a vat *half way up* on our house side
Like blood the juice spins.
While your brother, *all* bare-legged, is dancing,
Till breathless he grins.
Dead beaten in effort on effort
To keep the grapes under,
Since *still* when he seems *all but master*,
In pours the fresh plunder
From girls who keep *coming* and going,
With basket on shoulder,
And eyes shut against the rain's driving,
Your *girls* that are *older*.

(2) Learn 50 Roots, with meanings and examples.

(3) *Literature.*—Revise your notes on Literature from 1485 to 1740.

(4) Revise any points in Grammar not known, and prepare answers where necessary to the following questions.

Selected Scholarship Questions in Grammar.

1. Make a list of Auxiliary Verbs, distinguishing those of mood from those of tense.

2. Give examples of English words, in which differences of case, number, gender, degree, mood, tense, and voice, are indicated by inflexions.

3. Point out the historical order in which the several foreign elements were incorporated into the English language. During what period did English seem to be dying o t, and under what circumstances and influences did it revive?

4. Examine and illustrate the etymology of any five of the following words :—

Traveller, visage, passions, survive, despair, level, boundless, lone, decay, colossal, desert, lip, pedestal.

5. Show by definition and examples what is meant by (*a*) substantive, (*b*) intransitive, (*c*) passive, (*d*) defective, (*e*) strong (irregular), and (*f*) weak Verbs. To which of the two last-named classes would you refer the verbs *to lead, to spread, to show, to sweep, to spend*, and why?

6. Give your definitions of an Adverb, a Preposition, and a Conjunction, and show by examples the difference between each of them and the other two. Can you mention any words belonging to these three classes which cannot be parsed without knowing their position in a sentence?

7. Give a short historical sketch, with date, of the origin and growth of the English language.

8. Distinguish common, proper, and abstract nouns; co-ordinal and ordinal numbers; intransitive and neuter verbs; continuative and disjunctive conjunctions; personal, possessive, reflexive, and relative pronouns.

9. It is often said that English is less of an inflected language in its later than in its earlier stages. Explain what is meant by this, and give a few instances of inflection in English as now spoken.

10. Show by examples how analysis helps us to parse correctly.

11. At what periods, and in connection with what events, in the history of this island, did the most important changes take place in the language of its inhabitants? Illustrate your answer.

12. Name six of the most famous English writers. Say when each of them lived, and what book he wrote.

13. Take each of the following words, and add to it a prefix or a suffix. Explain in each case what change in the meaning of the word has been effected by the additional syllable :—

Just, admire, faith, pure, brother, friend, sincere, wise, heard, speak.

14. Explain each of the following grammatical terms, and give an example illustrating its use. Infinitive, Relative, Apposition, Government, Predicate, Dative, Subjunctive, Transitive, Inflection.

15. Show by example the different uses which may be made, in English, of the words 'what' and 'that.'

16. If you think there is anything wrong in any of the following sentences, correct it, and give your reasons.

(*a*) I should have liked to have seen so fine a sight.
(*b*) I do not think him a reliable person.
(*c*) There let him lay.
(*d*) Preferring to know the worst, than to dream the best.
(*e*) The courage of the soldier and of the citizen are essentially different.
(*f*) Each thought of others rather than themselves.
(*g*) The orator spoke of the notion that the national debt might be repudiated with absolute contempt.

17. How do you account for the presence in English of so many words of Latin origin? Say by what token, either as regards spelling or construction, you can recognise that an English word is derived from Latin; and give some examples.

18. Who were the chief dramatists who wrote during Elizabeth's reign?

19. Classify Adjectives. How are they inflected? How would you parse the word *white* in the sentence, 'I painted my house *white*'?

20. Give the meanings of the prefixes *extra-, ob-, be-, for-, ante-*. What do the suffixes- *ster, -ish, -ous, -let, -al*, denote respectively? Give an example in each case.

21. In what different ways may the infinitive mood be used? Give examples.

22. Name the different classes of Conjunctions and give an example of each.

23. Explain briefly the distinction between *shall* and *will*. Comment on the following, 'I will be drowned and nobody shall save me.'

24. If you see anything wrong in the following sentences, correct them and give your reasons :—

(*a*) I never remember to have seen him before.
(*b*) They deserve to receive condign punishment.
(*c*) Please to send either a written or verbal reply.
(*d*) I intended to have pointed this out yesterday.
(*e*) He hoped everyone had enjoyed themselves.
(*f*) The climate is as good, or even better than that of Madeira.

25. Give several words in which the following syllables are contained, and show, in regard to each group, what is the common element of meaning, and from what language the words are derived:—

Phil, rect, dom, tele, sent, tract.

26. Point out the difference in meaning between the words in each of the following pairs, and put each into a sentence of your own construction:—

Reverend and Reverent.	Permissive and Permissible.
False and Fallacious.	Benevolent and Beneficent.
Apathy and Antipathy.	Distinct and Dissimilar.

27. Give some rules for determining the case of relative pronouns in a sentence, and give examples of sentences containing relative pronouns in different cases.

28. Correct, if necessary, any of the following sentences, and give your reasons :—

(*a*) How sweet the moonlight sleeps upon this bank.
(*b*) I am sorry to differ with you.
(*c*) He is averse to the proposal.
(*d*) For thou art a girl as much brighter than her,
As he is a poet sublimer than me.
(*e*) These are the two persons whom he thought were far away.
(*f*) This England never did nor never shall
Lie at the proud foot of a conqueror.

29. Name the chief writings of the following authors :—Bacon, Pope, Johnson, Hume, Macaulay, and say when each of these writers lived.

30. Explain the meaning of each of these terms and make sentences containing illustrations of their use :—*Passive, Antithesis, Co-ordinate, Apposition, Infinitive of Purpose, Demonstrative, Ellipsis.*

31. State the requirements of the Code under the head of 'English' in Standard III., and show how the lessons may be utilised so as to teach the children to frame sentences and speak correctly.

32. From each of the words 'joy,' 'glory,' 'true,' 'wise,' form three other words by the addition of a suffix, introducing each word into a short sentence.

33. What do you mean by comparison of Adjectives? When ought the comparative and when the superlative form to be used? What classes of Adjectives do not admit of comparison?

34. Say what you know of any two of these writers:—Bacon, Johnson, Pope, Macaulay, and what books they wrote.

35. Explain the *case* of the words printed in italics in the following sentences :—

(*a*) He gave me *what* I wanted.
(*b*) The book is *mine*.
(*c*) *Him* the Almighty power
Hurled headlong.
(*d*) He *whom* thou lovest is sick.
(*e*) He was chosen *secretary*.
(*f*) *Weather* permitting I shall travel to-morrow.

36. Give examples from any poem you have read or learned (1) of simile, (2) of metaphor, (3) of personification.

37. Name any important books which were written in the eighteenth century, and say what you know of the authors of any two of them.

38. Distinguish between the meanings of the following words and use each in an appropriate sentence:—

allusion	illusion
compliment	complement
continual	continuous
deference	difference
influence	affluence
luxuriant	luxurious
prosecute	persecute
sufferance	suffering
urban	urbane.

39. Quote any passage, not exceeding ten lines, from any standard English poet (excluding Shakespeare and Milton) that you consider especially noteworthy on account of beauty of diction, and justify your selection by adequate reasons.

40. Comment on the following words, giving illustrations where you can, of similar grammatical forms:—*Afoot, yclept, twain, chaste, kine, gotten, prithee, wot, hindmost.*

41. Chaucer has been called 'the finder of our fair language.' Illustrate and amplify this statement.

42. Make a list of English words used in the time of Shakespeare or Milton, but now rarely or never used.

43. Comment on the words *italicised* in the following :—House *to let*—*These* sort of things—Woe *worth* the day—He is justified *in doing this*—*Meseemed* I was in heaven—You *ought* to go at once—Give *me* the book—Than *whom* no one is kinder.

44. Explain and derive the following terms:—Analysis—Literature—Vocabulary—Grammar—Plural—Mood—Interjection—Reciprocal.

45. Mention, with examples, any terminations of names of English places which show their origin.

4. *Arithmetic.*

Men.—During this month revise most carefully all the theory work connected with this subject. The following are some of the points which, perhaps, need attention:—Definitions of all terms employed; different methods of notation; scales; casting out nines as a proof of the simple rules; multiplication and division by factors; diagrammatic representation and proof of tables of weights and measures; proofs of the various operations with vulgar fractions; rules and proof of recurring decimals; ratio and proportion; the decimal and metric systems; proofs of G.C.M. and L.C.M., &c.

Prepare answers, where necessary, to the following questions which have been asked:—

(1) In dividing a number by 315 if I divide the number consecutively by 5, 7, 9, and obtain remainders 3, 2, 1, what is the complete remainder?

(2) Show that the ratio of two numbers may be expressed as a fraction.

(3) Make a diagram showing how a line or a cube may be divided in such a way as to prove the truth of the proposition $\frac{1}{2} - \frac{1}{3} = \frac{5}{24}$.

(4) Explain clearly in what sense $1 \cdot \dot{3}$ is represented by $1\frac{1}{3}$.

(5) Make a diagram showing that $\frac{1}{2} + \frac{1}{3} - \frac{1}{4} = \frac{7}{12}$.

(6) Give an example of inverse proportion, and explain the term inverse.

(7) How would you explain the fact, that in division of decimals the quotient may be larger than the dividend? Give an example.

(8) State and prove the rule for finding the L.C.M. of 3 or more numbers.

(9) Show by a diagram that $30\frac{1}{4}$ square yards make a square pole.

(10) Define ratio, proportion, interest, and discount.

(11) Prove the rule for the multiplication of fractions.

(12) Prove that $\frac{3}{8} \div 9 = \frac{1}{15}$.

(13) Prove the rule for finding a vulgar fraction equivalent to $\cdot 34\dot{5}$.

(14) Prove that seven times nine equals nine times seven.

(15) Resolve 6006 and 7854 into their prime factors; deduce their greatest common measure and prove (as to a class) that your answer *is* the greatest common measure.

(16) Prove the rule for division when the divisor is a number larger than 12.

(17) Distinguish between concrete and abstract numbers, between notation and numeration, and explain (as to Standard II.) the reason for the process of short division (*e.g.*, $5768 \div 3$).

(18) How would you explain to a class beginning fractions the error in the following? $\frac{3}{4} + \frac{2}{7} = \frac{3+2}{4+7} = \frac{5}{11}$.

(19) How would you teach a class to express two hundred and eight in numbers?

(20) Define prime number. How would you show that 481 is not a prime number?

(21) Explain the following terms:—Measure, Multiple, Average, Percentage, Consols, Interest, Discount.

(22) Show that if two numbers are divided by their G.C.M., the quotients are prime to each other.

(23) In what way can the process in subtraction, erroneously called 'borrowing and carrying' be justified?

(24) Show by a diagram that $\frac{1}{3}$ of $\frac{1}{4} = \frac{1}{12}$.

(25) If we add cyphers to the end of a decimal fraction the value is unaltered, but if we add cyphers at the end of a whole number the value of the number is changed. Explain this to a class of children.

Girls. *See* above.

5. *Algebra.*

Girls.—Read Chapters XX. and XXI. 'Scholarship Algebra,' and work all examples thereon.

Boys.—Study Chapters XXXI.–XXXIII. 'Scholarship Algebra,' and work all examples. Note particularly the methods of solution in Chapter XXXII.

During the month revise all theory work, such as proofs of G.C.M. and L.C.M., the operations with fractions, the various proofs in quadratic equations and their roots, &c. A question is generally set on this. Revise all rules in mensuration.

6. *Euclid.*

Revise thoroughly Book II. Be prepared to express the various propositions in algebraical form. Practise writing out regularly, and work as many deductions as possible.

Tabulate all the corollaries in Books I. and II., all the converse propositions, the propositions dealing with the equality of triangles and parallelograms, &c.

7. *Geography.*

(1) Practise memory maps regularly.

(2) Revise the American possessions.

(3) Prepare thoroughly the Geography of Scotland and Ireland. Chief points: Physical features, rivers' basins, industries, and productions; towns, government, etc. The following are a few questions on the colonies :—

(1) Name the chief productions imported into Great Britain from her possessions in Asia, specifying the place from which each of them comes to us.

(2) Enumerate the chief productions of British North America, Queensland, and Jamaica.

(3) Name the principal productions of six of the chief colonies of Great Britain, and classify their climates as temperate, tropical, or otherwise.

(4) State some of the routes which a person travelling to and returning from New Zealand might take, and give a full account of one of them.

(5) Ships come into English ports from Quebec, Calcutta, Cape Town, Adelaide, and Belfast. What are their probable cargoes?

(6) Give notes of a lesson on the employment of colonists in Western Australia or in Manitoba.

(7) Give a short account of the climate and productions of, and mention the principal towns in, the district between the Eastern Ghauts and the Bay of Bengal.

(8) Give some account of the various races inhabiting India.

(9) Give a short account of the climate and productions of Cape Colony or Canada.

(10) Give a summary of what you know about India under these heads: (*a*) Approximate size; (*b*) climate, with special reference to rainfall in different parts; (*c*) mountains.

(11) Write a summary of a journey from Liverpool to New Westminster.

(12) How is Victoria (in Australia) governed? What are its chief sources of wealth? What is the chief source of wealth in New South Wales? Say something about the aboriginal Australians.

8. *History—Elizabethan Literature.*

Learn carefully the following note :—

One of the most remarkable movements of the Tudor period, not only in England, but all over Western Europe, was the Revival of Learning, or the Renaissance as it is sometimes termed. Up to the fifteenth century, all Europe was engaged in continual wars, fighting for territory, devoting all its energy to the international and civil contests which were always raging. Learning was totally neglected, men of letters were despised, and the period was properly called the Dark Ages. In England, with the exception of Chaucer, there had been no writer of any great importance; but in Elizabeth's reign there arose an army of poets, dramatists, theologians, historians, and geographers. The causes of this sudden outbreak of national literature were as follows :—

(1) The taking of Constantinople by the Turks in 1453. This city had been the headquarters of such learning as there

was, and after its conquest the learned men who had lived there were scattered all over Europe, and took their learning with them.

(2) The stopping of the European wars to a large extent, which left men more leisure for learning.

(3) The introduction of printing, by which books could be multiplied rapidly, and consequently became much cheaper.

(4) The great religious controversy—Catholicism *v.* Protestantism—which set men reading and thinking for themselves.

(5) The foundation of numerous schools and colleges by means of the plunder of the monasteries.

(6) The intense national patriotism which had been carefully fostered by Elizabeth.

(7) The demand for something to replace the old Passion Plays or Mystery Plays given under the auspices of the monasteries, which gave rise to the Elizabethan drama.

(This last requires, perhaps, a few words of explanation. It was the custom during the Middle Ages to give periodically, at most of the large towns, plays representing, at first, scenes in the life of Christ or from the Old Testament, such as are still given in Ober-Ammergau. As time went on, additional characters and scenes were introduced, until the religious element was pretty well lost sight of. These plays were very popular, and when the monasteries were suppressed these popular pastimes naturally ceased. To supply their place we have the birth of the Drama.)

All the above causes combined to cause a great outburst of national song and thought, and the writers of the Elizabethan age have never been surpassed in vigour of expression and wealth of thought. The chief writers, of whom space forbids saying anything adequate, were as follows :—

I.—POETS.

Thomas Sackville, Lord Buckhurst—'Mirror for Magistrates.'
Sir Philip Sydney—'Sonnets.'
Edmund Spenser—'Faerie Queene,' 'Shepherd's Calendar,' Epithalamium,' etc.
Michael Drayton—'Polyolbion,' 'The Barons' Wars.'
Sir W. Raleigh.

II.—DRAMATISTS.

Nicholas Udall (1553)—'Ralph Roister Doister' (First Drama).
John Still (1565)—'Gammer Gurton's Needle' (First Comedy).
George Peele—'Edward I.,' 'Old Wives' Tale,' 'King David and Bethsabe.'
Thomas Nash—'Dido, Queen of Carthage,' and 'Pierce Penniless.'
Robert Greene—'Orlando Furioso,' 'Friar Bacon and Friar Bungay,' etc.
Christopher Marlowe—'Tamburlaine the Great,' 'Dr. Faustus,' 'Jew of Malta,' 'Edward II.'
William Shakespeare—'Hamlet,' 'King Lear,' 'Julius Cæsar,' etc.
Ben Jonson—'Every Man in His Humour, Every Man out of His Humour,' 'Volpone,' 'Epicene,' 'Alchemist.'
George Chapman—'Eastward Hoe,' 'Bussy d'Ambois,' etc.
Thomas Dekker—'Satiromastrix,' 'Fortunatus.'
Marsh, Massenger, Ford, etc.

III.—PROSE WRITERS.

John Fox—'Book of Martyrs.'
Sir Philip Sydney—'Arcadia,' 'Defence of Poesie.'
John Lyly—'Euphues, the Anatomy of Wit,' and 'Euphues and his England.'
George Puttenham—'The Art of English Poesie.'
Richard Hooker—'The Laws of Ecclesiastical Polity.'
Lord Bacon—'Essays,' 'Novum Organum,' 'Advancement of Learning,' 'Wit and Wisdom of the Ancients.'
Sir Walter Raleigh—'History of the World.'
W. Camden—'Britannia' (History).
Richard Hakluyt—'Voyages.'

This is by no mans a complete or exhaustive list of the writers, or the works of those mentioned. The literature may with advantage be studied from 'English Literature' (Macmillan & Co., 1s.).

Selected Scholarship Questions.

(1) Give a short sketch of the History of the Norman Conquest of England.

(2) Write an account of the character of King Edward III., and mention the leading events of his reign.

(3) What do you know of the dwelling-houses, dress, amusements, and domestic habits of Englishmen in the time of the Tudors?

(4) What is meant by the 'Revival of Learning'? When did it take place, and to what causes is it to be attributed? Mention some of the leaders in the movement in England and elsewhere.

(5) Mention the chief warriors, statesmen, and writers who flourished in the reign of Elizabeth, and give a particular account of one of them.

(6) Write a brief account of the reign of Henry VIII., illustrating especially the despotic character of his reign.

(7) Sketch the character of Henry V., and give an account of his conquest in France.

(8) What was the relationship of Mary I. to her husband, Philip of Spain, and of Mary Queen of Scots to her husband, Lord Darnley? Give genealogical tables in each case.

(9) Give as clear an account as you can of the cause of any *two* of the following popular outbreaks :—The Pilgrimage of Grace, Jack Cade's rebellion, the risings in the time of Edward VI.

(10) Explain what is meant by the Star Chamber, Act of Supremacy, Poyning's Law, Royal Prerogative.

(11) Compare Henry II. and Edward I. with regard to—
(*a*) Extending the dominions of the Crown.
(*b*) The administration of justice.
(*c*) Relations with the clergy.

(12) Who was the wife of Henry II.; Edward II.; Henry VI.? Which of these kings acquired or lost territory by marriage? What active parts in historical events did their wives take.

(13) Mention, with dates, risings in the times of the Tudors which were due to discontent caused by religious changes, taxation, or poverty. Mention (*a*) causes which in that period produced distress and vagrancy, (*b*) any measures taken to meet these evils.

(14) Give a summary of the relations of King and Parliament throughout the Tudor period.

(15) What were the general objects of the following:—Salisbury Decree (1086), Constitutions of Clarendon (1164), Magna Charter (1215), De Religiosis (1279), Statute of Labourers (1349), Statute of Kilkenny (1357), Statute of Supremacy and Uniformity (1559).

(16) Trace the relations between England and Scotland at the following epochs :—Edward I. to Edward III., Henry VII. and VIII., Elizabeth.

9. *School Management.*—Revise the teaching of Arithmetic, Geography, Grammar, History, and the other ordinary school subjects.

10. *Domestic Economy.*—Revise Clothing, Needlework, and Investments.

11. *Music.*—Revise all, paying especially attention to transposition and the minor scale.

12. *French.*—Finish 'Le Trésor.' Revise all important points in Grammar.

TEST QUESTIONS.

1. Give some account of the chief satires that have been written in English, or the chief historians.

2. Give examples of the following figures of speech from any poem you may have learnt :—Personification, Metaphor, Simile, Hyperbole, and Metonomy.

3. *Girls.*—(*a*) If $a = 16$, $b = 10$, $x = 5$, $y = 1$, find the value of

$$(x - b)(\sqrt{a} - b) + \sqrt{(a - b)(x + y)}. \quad \text{Ans. } 36.$$

(*b*) Find the remainder when $y^3 - xy^2 + 3x - 4$ is taken from $y^3 - xy^2 + 2y - 2$. Ans. $-3x + 2y + 2$.

(*c*) Simplify—
$3(a-b)-[3a-(b-a)-\{3a-b+2a-b\}]$.
Ans. $4a-4b$.

(*d*) Multiply—
$3x^3-4x^2y+4xy^2-y^3$ by $2x^2-xy-y^2$.
Ans. $6x^5-11x^4y+9x^3y^2-2x^2y^3-3xy^4+y^5$.

(*e*) Divide the produce of x^2-4 and x^2-4x by x^2+2x.
Ans. x^2-6x+8.

(*f*) Solve $\frac{x+3}{2}-\frac{11-x}{5}=\frac{3x-1}{20}+3\frac{1}{5}$. Ans. 7.

(*g*) Solve—
$7x-\{4x-1-(6x+4)\}=27-2[5x-(3x+2)]$.
Ans. 2.

Men.—(*a*) Simplify—

(i.) $\dfrac{\frac{1}{a^2}+\frac{1}{b^2}}{\frac{1}{a^2}-\frac{1}{b^2}}\div\dfrac{\frac{1}{a}+\frac{1}{b}}{\frac{1}{a}-\frac{1}{b}}$. Ans. $\frac{a^2+b^2}{(a+b)^2}$.

(ii.) $\frac{1}{a}\left(\frac{1}{x-a}+\frac{1}{x+2a}\right)-\frac{3}{x^2+ax-2a^2}$.
Ans. $\frac{2}{a(x+2a)}$.

(*b*) Find the G.C.M. of—
$3x^3+10x^2+7x-2$ and $3x^3+13x^2+17x+6$,
Ans. $x+2$.
and the L.C.M. of—
x^2-5x+6, x^2-4x+3, x^2-3x+2.
Ans. $(x-1)(x-2)(x-3)$.

(*c*) Solve $11x-10y=14$ and $5x+7y=41$.
Ans. 4 and 3.

(*d*) $\frac{ax}{b}-\frac{1}{b}\left(\frac{1}{c}+x\right)+d=\frac{d}{b}\left(bx-\frac{1}{cd}\right)-\frac{x}{6}+\frac{a}{b}$.
Ans. 1.

(*e*) How much sugar at 4d. per lb. must be mixed with 20 lbs. at 5½d. that the mixture may be worth 5d. per lb.?
Ans. 10 lbs.

(*f*) Show that the sum of the two roots of the equation $x^2+px+q=0$ is equal to $-p$.

(*g*) $\sqrt{2x+8}+2\sqrt{x+5}=2$. Ans. ± 4.

4. (*a*) From the angles P and Q of a triangle PQR perpendiculars are drawn to the opposite sides meeting them produced, if necessary, in K and L. Prove that the straight lines which join K and L to the middle point of the side PQ are equal to each other.

(*b*) Show that the square on the sum of two straight lines together with the square on their difference is double the squares on the two straight lines.

(*c*) Describe a square equal to any given rectilinear figure.

5. (*a*) What are alpaca, velvet, holland, print, serge, and muslin?

(*b*) What are disinfectants? Name some which are inexpensive and effective, and say how they should be used.

(*c*) What facilities for investment do the Post Office authorities offer to schools? and what facilities for making sound investments are open to persons of small income?

6. Write as specimens of copysetting—Large-hand, *Hydrographical*; small-hand, *Necessity is often the mother of invention.*

7. (*a*) Name the following intervals—
s–f', n–l, f–de', r–se, d–re, r–ta, fe–ra', ra–de'.

(*b*) Write the minor scale ascending, using the minor sixth and major seventh, and again descending, using the minor seventh and minor sixth.

(*c*) Explain the following terms:—Legato, Fortissimo, Mezzo Forte, Leggiero, Accelerando, Lento, Presto, Crescendo.

CORRESPONDENCE.

1. Individual assistance will be given as far as possible by advice, solution of difficulties in any subjects, model answers, etc.

2. Specimens of Writing, Paraphrasing, Maps, Composition, etc., will be marked and criticised gratis.

3. To assist students in rural districts, Freehand or Model Drawings will be corrected and marked, with hints for improvement, etc., and returned if accompanied by a postage stamp.

4. As a rule, all replies will appear in the Correspondence Column, but anyone desiring an immediate reply may obtain it by enclosing a stamped, addressed envelope.

5. To ensure an answer in the next issue queries must be sent by the 15th of each month.

6. Name and address of sender, with coupon of current number of the PRACTICAL TEACHER, and *nom de plume* if desired, must be enclosed.

All communications and queries with regard to these courses to be addressed to Arthur T. Flux, 12, Lower Park Road, Belvedere, Kent.

ANSWERS TO CORRESPONDENTS.

TRUBADA.—Large-hand, 85 per cent. Small-hand, 75 per cent. The latter is irregular in size and shaky.

HAREBELL.—80 per cent. The small-hand lacks decision, the looped letters are rather too long, and the letter *r* awkwardly formed. The heighth of the *d* is a matter of taste; I should advise the same height as the *t*.

NYMPH.—A very good essay. 80 per cent. You should divide into paragraphs, insetting the commencement of each, and let each paragraph deal with one set of ideas.

MERMAID.—Very good. 90 per cent. See answer to 'Nymph.'

Y.Z.A.—Yes. I should think so.

MARY.—Your writing is very good; quite up to the average. The letters are rather too round, they should be oval. The essay is fairly good—75 per cent.—but the style requires more vigour. What you have said might easily be condensed to half the amount.

E.W.B.—The diagonals are never equal. Draw a figure and you will see at once.

ANSWERED BY POST.—J.C. (Plymouth); R.A. (Handbridge); E.W.A. (Long Eaton); M.H. (Birtley); R.J.C. (Morpeth); E.M.A. (Llanelly); A.B.M. (Street); J. T. (Great Crosby); G.R.M. (Blackpool); E.L. (Skelton); A.V. (Cemmaes); R.B. (Shields); E.C. (Shields); M.A.D. (Ipswich); J.T. (Newcastle); L.H. (Coventry); A.H. (Burslem); R.J.H. (Durham); L.M., E.W. (Corwen); H.M., E.L.M. (Milton); S.B., A.B. (Thirsk); W.E. (Rochdale); A.H. (Widnes); A.L. (Bridlington); J.H. (Benwell); S.F. (Grangetown); A.B. (Olton); K.H.N. (Bournemouth); J.R. (Whitland); M.T. (Crook); Reader (Montrose); K.L. (Charlesworth); M.C. (Auckland); E.J.S. (Bridgewater); M.J.W. (Whitehaven); E.W.B. (Blackpool).

MODEL ANSWERS TO PUPIL TEACHERS' EXAMINATION, October, 1895.

ARITHMETIC.

First Year—Boys.

1. What do you understand by $\frac{4}{5}\times\frac{3}{7}$? Find its value, giving clear reasons for each step in the process.

$\frac{4}{5}\times\frac{3}{7}$ means that $\frac{4}{5}$ or $\frac{1}{5}$ of a unit is to be multiplied by $\frac{3}{7}$ of another unit, $=\frac{3}{14}$. The process of obtaining this result is to multiply the numerators of the fractions for a new numerator and the denominators for a new denominator. The reason for this is obvious—If $\frac{1}{5}$ is multiplied by 3 the result is $\frac{3}{5}$, but as we multiply by 3, which is 7 times as large as $\frac{1}{7}$, the result is 7 times too large. Hence $\frac{3}{5}$ must be divided by $7=\frac{3}{14}$.

2. Multiply 38·012 by 169·26, and divide the product by ·00104.

38·012
169·26
228072
76024
34308
228072
38012
6126·11112

·00104) 6126·11112 (
104) 612611112 (5890491·461538
520
926
832
941
936
511
416
951
936
152
104
480
416
640
624
160
104
560
520
400
312
880
832
480

3. Divide the sum of the greatest and least of the following fractions by the difference of the other two, $\frac{1}{2}$, $\frac{7}{8}$, $\frac{23}{28}$, $\frac{12}{13}$:—

$$\frac{30360}{35880} \quad \frac{31395}{35880} \quad \frac{31200}{35880} \quad \frac{31096}{35880}$$

$$\frac{31395 + 30360}{35880} \div \frac{31200 - 31096}{35880}$$

$$\frac{61755}{35880} \div \frac{104}{35880}$$

$$\frac{61755}{35880} \times \frac{35880}{104}$$

$$\frac{61755}{104} = 593\frac{83}{104}. \quad \text{Ans.}$$

4. Simplify $\frac{\frac{3}{8}(\frac{1}{3} - \frac{1}{4}) \text{ of } \frac{1}{10} \text{ fur.} - \frac{1}{3}(\frac{2}{11} - \frac{1}{6}) \text{ of } 4\frac{1}{2} \text{ pls.}}{\frac{1}{3}(\cdot 02 - \cdot 01\frac{1}{3}) \text{ of } 2\frac{1}{2} \text{ miles.}}$

$$= \frac{\frac{1}{8}\cdot\left(\frac{1}{35}\right) \text{ of } \frac{7}{10} \times \frac{40}{1} - \frac{1}{3} \times \frac{1}{66} \times \frac{3}{2}}{\frac{1}{3} \times \frac{85}{9000} \times \frac{5}{2} \times \frac{7}{1} \times \frac{40}{1}}$$

$$= \frac{1 - \frac{1}{44}}{\frac{119}{108}}$$

$$= \frac{\frac{43}{44}}{\frac{119}{108}} = \frac{1101}{2176}.$$

5. A quarter of wheat cost me £1 8s. 6d; some of it I sold at 4s. a bushel, and the rest at 1s. 2d. a peck. I gained 4s. 6d. How much did I sell at each price?

Let N = number of pecks sold at 1s.

32 − N = ,, ,, ,, 1s. 2d.

Then $N + 1\frac{1}{8}(32 - N) = 33$.

$6N + 224 - 7N = 198$.

$N = 26$. Ans. 26 at 1s.; 6 at 1s. 2d.

6. A man owned $\frac{19}{17}$ of a ship; he sold first $\frac{2}{3}$ of his share, and then $\frac{3}{4}$ of the remainder. The value of the remainder was £130. Find the value of the whole ship.

1. He sold $\frac{2}{3}$ of his share and had $\frac{1}{3}$ left.

$\frac{1}{3}$ of $\frac{19}{17} = \frac{19}{136}$.

2. He sold $\frac{3}{4}$ of this and had $\frac{1}{4}$ left.

$\frac{1}{4}$ of $\frac{19}{136} = \frac{19}{544}$.

$\frac{19}{544}$ of the ship = £130.

$\frac{1}{544}$,, ,, $= \frac{130}{19}$.

1 ,, ,, $= \frac{\overset{10}{\cancel{130}} \times 544}{\underset{3}{\cancel{19}}} = \frac{5440}{3}$

$= £1813\ 6s.\ 8d.$ Ans.

First Year.—Girls.

1. Explain, as to a class of Standard V. children, the way to find the L.C.M. of 12, 16, 18, 24, giving reasons for each step of the process.

2)12, 16, 18, 24
2) 8, 9, 12
2)4, 9, 6
3)2, 9, 3
2, 3, 1.

$2 \times 2 \times 2 \times 3 \times 2 \times 3 = 144$, L.C.M. Ans.

Strike out 12 because it is a factor of 24, and what 24 will divide into, 12 must. Then proceed to divide by any prime number which is a factor of two of the given numbers, bringing down intact those numbers which are not divisible. Continue this till the remainders are prime to each other. Then multiply all the divisors and remainders together, and the result is the L.C.M

Find the L.C.M. of 936, 2925.

$936 = 117 \times 8$;

$2925 = 117 \times 15$. L.C.M. $= 117 \times 15 \times 8 = 14040$. Ans.

2. Find, by Practice, the value of 19 tons 19 cwt. 3 qrs. 26 lbs., at 20 guineas a ton.

		£	s.	d.		tons.	cwt.	qrs.	lbs.
10 cwt. of 1 ton	½	21	0	0	cost of	1			
			19						
		399	0	0	,,	19	0	0	0
5 cwt. of 10 cwt.	½	10	10	0	,,		10	0	0
2 cwt. of 10 cwt.	⅕	5	5	0	,,		5	0	0
2 cwt. of 10 cwt.	⅕	2	2	0	,,		2	0	0
2 qrs. of 2 cwt.	¼	2	2	0	,,		2	0	0
1 qr. of 2 qrs.	½		10	6	,,			2	0
14 lbs of 1 qr.	½		5	3	,,			1	0
7 lbs. of 14 lbs.	½		2	$7\frac{1}{2}$	,,				14
4 lbs. of 1 qr.	¼		1	$3\frac{3}{4}$	,,				7
1 lb. of 4 lbs.	¼			9	,,				4
				$2\frac{1}{4}$	,,				1
Ans. £419 19s. $7\frac{1}{2}$d.						19	19	3	26

3. From an income of £155 a year, a man saves 15 guineas. He pays £33 10s. 4d. for rent, etc., and the remainder for clothes, food, etc. Calculate the amount spent per week.

	£	s.	d.
Amount saved - - -	15	15	0
Paid for rent, etc. - - -	33	10	4
Total	49	5	4

Income £155 0 0
Less 49 5 4

52) 105 14 8 (2
104

1
20
52) 34 (0
12
52) 416 (8
416
...

Ans. £2 0s. 8d.

4. A housekeeper pays 5s. 11½d. for 7 lbs. 2 oz. of beef, 4s. 8½d. for 4 lbs. 11 oz. of lamb, and 7½d. for ¾ lb. of suet. Find the price per lb. in each case.

(*a*) Cost of $7\frac{1}{8}$ lbs. = 5s. 11½d.
,, 1 lb. = 5s. 11½d. ÷ 57/8 = 10d.
(*b*) ,, $4\frac{11}{16}$ lbs. = 4s. 8½d.
,, 1 lb. = 4s. 8½d. ÷ $\frac{75}{16}$ = 1s.
(*c*) ,, ¾ lb. = 7½d.
,, 1 lb. = $7\frac{1}{2} \times \frac{4}{3}$ = 10d.

Ans. 10d.; 1s.; 10d.

5. Simplify $37\frac{3}{5} + 18\frac{1}{5} - 65\frac{1}{10} + 15\frac{2}{5} - 4\frac{5}{6}$.

(*a*) $37 + 18 - 65 + 15 - 4 = 1$.

(*b*) $\frac{3}{5} + \frac{1}{2} - \frac{1}{10} + \frac{2}{9} - \frac{5}{6}$.

$$= \frac{60 + 72 - 9 + 20 - 75}{90}$$

$$= \frac{68}{90} = \frac{34}{45}.$$

Ans. $1\frac{34}{45}$.

6. A man owned ⅓ of a ship, and after buying additional shares equal to ⅖ of the ship, his total interest in her was worth £28,700. What was the value of the ship?

$\frac{1}{3} + \frac{2}{5} = \frac{11}{15}$.

$\frac{11}{15}$ of the ship was worth £28,700.

$\frac{1}{15}$,, ,, ,, $\frac{28700}{14}$,

$\frac{15}{15}$,, ,, ,, $\frac{28700 \times 15}{14} = 30,750$

Ans. £30,750.

Second Year.—Boys.

1. Explain clearly why all fractions cannot be expressed as terminating decimals? Why, if they do not terminate, need they recur?

A decimal fraction is one which has some power of 10 for its denominator which is not expressed. Any fraction, therefore, whose denominator can be made a power of 10 by multiplying by any number can be expressed as a finite decimal, and this is only the case when the prime factors of the denominator consist of 2's and 5's. If any other number occur as a factor the fraction cannot be expressed as a finite decimal, *e.g.* ⅓. In this case no multiple of 3 is an exact power of 10, and hence the fraction cannot be converted into a finite decimal.

All fractions, if they do not produce a finite decimal, must produce a recurring decimal. For if the division is carried far enough, the same remainder is bound to recur. Take, for instance, $\frac{1}{13}$. There are 12 possible remainders, these are exhausted after dividing 12 times, and the thirteenth remainder must be one of the preceding 12. Therefore we get a decimal recurring at the 13th figure.

2. I have £8,000 invested in a 3½ per cent. stock. I sell £7,000 at 103 and invest in 4 per cent. Railway stock at 140. How much has my income been lessened (neglect brokerage)?

(*a*) Income on 100 = 3½;
,, 8,000 = $3\frac{1}{2} \times 80$ = £280.

(*b*) £100 stock sells for 103;
£7,000 ,, ,, 103×70.

(*c*) Income on £140 cash = £4;

,, £1 ,, $= \frac{4}{140}$;

,, 103×70 ,, $= \frac{4 \times 103 \times 70}{140}$

= £206.

(*d*) Income from £1000 remaining in 3½ per cents. = 35.
Total £241.

Loss of Income = 280 − 241 = £39 Ans.

3. A man walks at the rate of 12 miles in 3½ hours. He starts at 8.45 a.m. for a town 10 miles distant. How far is he from his destination at 5 minutes past 11 a.m.?

Distance walked in 3½ hours = 12 miles.
,, ,, 1 hour = $12 \div 3\frac{1}{2} = 3\frac{3}{7}$ miles.
From 8.45 to 11.5 = 2⅓ hours.
Distance walked = $3\frac{3}{7} \times 2\frac{1}{3}$

$$= \frac{24}{7}8 \times \frac{7}{3} = 8 \text{ miles.}$$

Distance from destination = 2 miles. Ans.

4. I sell a house at a profit of 12 per cent. on what it cost me. Had I received £20 more for the house my profit would have been $14\frac{2}{7}$ per cent. What did I give for the house?

Let £100 be cost price. Then £112 selling price *a*, and £$114\frac{2}{7}$ selling price *b*, a difference of £$2\frac{2}{7}$.

Then sum to produce a difference of £$2\frac{2}{7}$ = 100
,, ,, ,, ,, £1 = $100 \div 2\frac{2}{7}$
,, ,, ,, ,, £20 = $\frac{100 \times 20}{2\frac{2}{7}}$

= £875 Ans.

5. At what rate per cent. will £735 10s. amount to £804 19s. 0¾d. in 2½ years?

	£	s.	d.
Amount =	804	19	$0\frac{3}{4}$
Principal =	735	10	0
Interest =	69	9	$0\frac{3}{4}$

	£	s.	d.
Interest for 2½ years =	69	9	$0\frac{3}{4}$
,, ,, 1 year =	69	9	$0\frac{3}{4} \div 2\frac{1}{2}$
=	138	18	$1\frac{1}{2} \div 5$
=	27	15	$7\frac{1}{2}$

	£	s.	d.
Interest on £735 10s. for 1 year =	27	15	$7\frac{1}{2}$
,, ,, £1 for year =	27	15	$7\frac{1}{2} \div 735\frac{1}{2}$
,, ,, £100 for one year =	27	15	$7\frac{1}{2} \times 100$

$735\frac{1}{2}$

£3 $15\frac{800}{1471}$.

6. The values of two boxes of eggs are as 5 is to 6. Each egg in the second box is worth half as much again as each egg in the first box. There are 400 more eggs in the first box than in the second. How many eggs are there in each box?

Suppose there were 100 eggs in box 1, and let the price of each be 1d. Then value = 100d. By Question, value of second box would be 120d., and as each egg would be worth 1½d., there would be 80 eggs.

No. of eggs to produce a difference of 20 = 100.
,, ,, ,, 400 = 2,000.

Ans. 2,000; 1,600.

Second Year—Girls.

1. (*a*) Distinguish between prime and composite numbers.
(*b*) Resolve 1560 and 1638 into prime factors, and write down the prime factors of their G.C.M. and L.C.M.

(*a*) A prime number is a number which has no factor larger than unity. A composite number may be resolved into factors each larger than unity.

(*b*) $1560 = 2 \times 5 \times 2 \times 2 \times 3 \times 13$.
$1638 = 2 \times 3 \times 3 \times 7 \times 13$.
G.C.M. $= 2 \times 3 \times 13$.
L.C.M. $= 2 \times 5 \times 2 \times 2 \times 3 \times 13 \times 3 \times 7$.

2. A can do a piece of work in 3½ days, and B in 2½ days. They work together for a day, and then A leaves B to finish the work alone. How long will B take to finish it?

A can do the work in 3½ days, ∴ he does $\frac{2}{7}$ per day.
B ,, ,, 2½ ,, ∴ ,, $\frac{2}{5}$,,
In the first day they do $\frac{2}{7} + \frac{2}{5} = \frac{24}{35}$, leaving $\frac{11}{35}$ to be done by B.
Time for B to do $\frac{2}{5}$ = 1 day.
,, ,, 1 = $\frac{5}{2}$,,
,, ,, $\frac{11}{35} = \frac{5}{2} \times \frac{11}{35} = \frac{11}{14}$ day. Ans.

3. Find the value of $\frac{4}{5} + \frac{1}{3}$ of $(2 - \frac{1}{3}) - \frac{1}{5}$ of $2\frac{1}{2} + \frac{1}{2} - \frac{1}{4}$ of $(\frac{5}{8} - \frac{1}{2})$.

$\frac{4}{5} + \frac{1}{3} \times \frac{5}{3} - \frac{1}{5} \times \frac{5}{2} + \frac{1}{2} - \frac{1}{4} \times \frac{1}{2}$.
$\frac{4}{5} + \frac{5}{9} - \frac{5}{12} + \frac{1}{2} - \frac{1}{12}$.
$\frac{16 + 20 - 15 + 18 - 3}{36} = 1$. Ans.

4. Reduce $3\frac{5}{6}$ of £1 0s. 9½d. to the fraction of £1 10s. 10d.; and $3\frac{3}{7}$ weeks to the fraction of 1 day $8\frac{2}{3}$ hours.

(*a*) $\frac{3\frac{5}{6} \times £1 \text{ 0s. } 9\frac{1}{2}\text{d.}}{£1 \text{ 10s. } 10\text{d.}} = \frac{£3 \text{ 14s. 0d.}}{£1 \text{ 10s. } 10\text{d.}} = 2\frac{2}{5}$.

(*b*) $\frac{3\frac{3}{7} \times 7 \times 24}{32\frac{2}{3}} = \frac{24}{7} \times \frac{7}{1} \times \frac{24}{1} \times \frac{8}{261} = \frac{512}{29} = 17\frac{19}{29}$.

Ans. (*a*) $2\frac{2}{5}$; (*b*) $17\frac{19}{29}$.

5. Express as decimals $5 + \frac{3}{10} + \frac{7}{1000}$, $\frac{5}{16}$, $6\frac{5}{16}$, $\frac{6}{7}$.

$5 + \frac{3}{10} + \frac{7}{1000} = 5 + \cdot 3 + \cdot 007 = 5\cdot 307$.

$\frac{5}{16} = \cdot 03125$; $6\frac{5}{16} = \cdot 0078125$; $\frac{6}{7} = \cdot \dot{8}57142\dot{8}$.

Ans. $5\cdot 307$; $\cdot 03125$; $\cdot 0078125$; $\cdot \dot{8}57142\dot{8}$.

6. Find the value of $3\frac{7}{13}$ of 2s. $8\frac{1}{2}$d. + $4\frac{5}{10}$ of 7s. $1\frac{1}{2}$d. — $2\frac{1}{7}\frac{1}{7}$ of 10s. $7\frac{1}{2}$d. + $\frac{4}{5}$ of 7 guineas.

	s. d.	£ s. d.
$3\frac{7}{13}$ of	2 $8\frac{1}{2}$	= 9 7
$4\frac{5}{10}$ of	7 $1\frac{1}{2}$	= 1 10 $4\frac{1}{2}$
$\frac{4}{5}$ of 7 guineas		= 3 5 4
		5 5 $3\frac{1}{2}$
$2\frac{1}{7}\frac{1}{7}$ of 10	$7\frac{1}{2}$	= 1 8 $1\frac{1}{2}$
		3 17 2. Ans.

Third Year—Boys.

1. Find the square root of 100489, explaining fully the reason for the rule of pointing.

	10,04,89 (317
	9
61	104
	61
627	4389
	4389

The reason for pointing in periods of two figures arises from a consideration of the squares of number.

The square of any one figure is always not more than two, the square of two figures is always more than *two* figures, and not more than *four*, and so on. Hence the square of two figures will always be one, the square root of three or four, two, etc.

2. If 31 books cost £6 3s. $4\frac{1}{2}$d., how many can be bought for £53 18s. $4\frac{1}{2}$d. ?

No. of books for £6 3s. $4\frac{1}{2}$d. = 31.

$$£1 = \frac{31}{£6\ 3s.\ 4\frac{1}{2}d.}$$

$$£53\ 18s.\ 4\frac{1}{2}d. = \frac{31 \times £53\ 18s.\ 4\frac{1}{2}d.}{£6\ 3s.\ 4\frac{1}{2}d.} = \underline{271 \text{ books.}}$$

3. Arrange the following expressions in order of magnitude :—

$\frac{3}{4}$ of $\left(1\frac{1}{3} - \frac{5}{8}\right)$; $\frac{\cdot 037}{\frac{3}{11}\text{ of }(\frac{5}{8} - \frac{1}{4})}$; $\frac{\frac{1}{2} + \frac{1}{3} - \frac{1}{4} - \frac{1}{5}}{3\frac{1}{10} - 2\frac{1}{5}\frac{7}{5}}$.

$\frac{3}{4}$ of $\frac{17}{24}$; $\frac{34}{\cdot 0088}$; $\frac{5}{11}$ of $4\frac{1}{2}$; $4\frac{5}{12} - \frac{1}{30}$.

$\frac{17}{32}$; $\frac{1112}{2128}$; $\frac{12}{25}$.

17.35.45 ; 110.32.5 ; 18.32.45.

32.35.45

25775 : 10040 : 25920

32.35.45.

Ans. $\frac{17}{32}$; $\frac{12}{25}$; $\frac{1112}{2128}$.

4. Find the value in decimals of $\frac{12\cdot 0785}{\cdot 012092} \times \cdot 021112$.

000013

$12\cdot 0785 \times \cdot 021112$

012092

000008

$12\cdot 0785 \times 13 = \underline{19\cdot 6275625}$. Ans.

8

5. I hold some shares in a $4\frac{1}{2}$ per cent. railway stock which bring me in an income of £193 10s. I sell out at $107\frac{1}{4}$, and buy $3\frac{1}{2}$ per cent. stocks at $96\frac{3}{4}$, what income shall I now have ? (Neglect brokerage.)

(*a*) Stock he'd to produce £$4\frac{1}{2}$ = 100.

,, ,, £1 = $100 \div 4\frac{1}{2}$.

,, ,, £$193\frac{1}{2}$ = $\frac{100 \times 193\frac{1}{2}}{4\frac{1}{2}}$

= £4,300 stock.

(*b*) £100 stock produces £$107\frac{1}{4}$ cash.

£1 ,, ,, £$\frac{107\frac{1}{4}}{100}$.

£4,300 ,, ,, £$\frac{107\frac{1}{4}}{100} \times \frac{4300}{1} = 107\frac{1}{4} \times 43$

(*c*) £$96\frac{3}{4}$ cash produces income of £$3\frac{1}{2}$.

£1 ,, ,, £$\frac{3\frac{1}{2}}{96\frac{3}{4}}$.

£$107\frac{1}{4} \times 43$,, ,, £$\frac{3\frac{1}{2} \times 107\frac{1}{4} \times 43}{96\frac{3}{4}}$

$= \frac{7}{2} \times \frac{429}{4} \times \frac{43}{1} \times \frac{4}{387} = \underline{£166\ 16s.\ 8d.}$ Ans.

6. A can reap a field in 14 hours, B in 16 hours, C in 18 hours. A begins to reap it at 8 a.m. B joins him at 9 a.m. When should C join them that they may finish at 3 p.m. ?

A does the whole in 14 hours, ∴ he does $\frac{1}{14}$ per hour.

B ,, ,, 16 ,, ∴ ,, $\frac{1}{16}$,,

C ,, ,, 18 ,, ∴ ,, $\frac{1}{18}$,,

Between 8 and 9 A does $\frac{1}{14}$.

Between 9 and 3 A and B do $6(\frac{1}{14} + \frac{1}{16}) = \frac{45}{56}$.

Total done by A and B = $\frac{1}{14} + \frac{45}{56} = \frac{49}{56}$.

Therefore C has to do $\frac{7}{56}$ or $\frac{1}{8}$.

Time for C to do $\frac{1}{18}$ = 1 hour.

,, ,, 1 = 18 hours.

,, ,, $\frac{1}{8}$ = $\frac{18}{8}$ hours = $2\frac{1}{4}$ hours.

∴ C must start at 12.45. Ans.

Girls.

1. State and prove the rule for reducing a pure recurring decimal to a Vulgar Fraction.

Rule.—Take the decimal figures as the numerator of the fraction and as many 9's for the denominator as there are recurring figures.

Proof.—Take for example $\cdot 3\dot{2}\dot{5}$. Let N be the desired fraction.

Then N = $\cdot 325325325$, etc., to infinity ;

1000 N = $325\cdot 325325325$, etc., to infinity.

Subtract the first line from the second.

999 N = 325 ;

N = $\frac{325}{999}$,

which establishes the rule.

(*b*) Multiply $\cdot 39\dot{2}85714\dot{2}$ by $2\cdot 5\dot{4}$.

$\cdot 39\dot{2}85714\dot{2} = 39\frac{2}{7} = \frac{39\frac{2}{7}}{100} = \frac{275}{700}$.

$2\cdot 5\dot{4} = 2\frac{5}{9}\frac{4}{9} = 2\frac{6}{11} = \frac{28}{11}$.

$\frac{275}{700} \times \frac{4}{28} = \frac{1100}{1100} = 1$. Ans. 1.

2. Reduce £$2\cdot 525 + 3\cdot 2\dot{7}$ of 15s. to the decimal of 16s.

£ 2·525 $3\frac{27}{99} \times 15$

20

£50·500 + $49\frac{1}{9}$

$50\frac{1}{2} + 49\frac{1}{9} = 99\frac{3}{8}$.

Decimal = $\frac{99\frac{3}{8}}{16} = \frac{299}{48} = \underline{6\cdot 22916}$. Ans.

3. After paying income tax at the rate of 7d. in the £, a person had £734 13s. $6\frac{3}{4}$d. What was his gross income ?

Gross income of 19s. 5d. = £1.

,, ,, £1 = $\frac{1}{19s.\ 5d.}$.

,, ,, £734 13s. $6\frac{3}{4}$d. = $\frac{£734\ 13s.\ 6\frac{3}{4}d.}{19s.\ 5d.}$

= £756 15s. 0d. Ans.

4. Find the value in tons, cwts., etc., of $2\cdot 1\dot{6}$ of 3 tons 12 cwt. + $\cdot 142857\dot{1}$ of 1 cwt. 3 qrs. 22 lbs. + $\cdot 75$ of a cwt. + $3\cdot 8\dot{3}$ of 9 lbs. 13 oz.

	tons.	cwt.	qrs.	lbs.	oz.
$2\cdot 1\dot{6} = 2\frac{1}{6}$ of 3 tons 12 cwt. =	7	16	0	0	0
$\cdot 142857\dot{1} = \frac{1}{7}$ of 1 cwt. 3 qrs. 22 lbs. =			1	3	$2\frac{4}{7}$
$\cdot 75 = \frac{3}{4}$ of 1 cwt. =			3	0	0
$3\cdot 8\dot{3} = 3\frac{5}{6}$ of 9 lbs. 13 oz. =			1	9	$6\frac{6}{7}$
Ans.	7	16	1	12	$12\frac{4}{7}$

5. In a school the ratio of children in the first class to the whole school is 1 in 7; in the second class 5 in 12; in the third class 8 in 21; the remaining children, 15 in number, are infants. Find the total number of children in the school.

Fraction of school in classes $= \frac{1}{7} + \frac{5}{12} + \frac{8}{21} = \frac{73}{84}$.

Remainder $= \frac{11}{84}$.

Then $\frac{11}{84}$ of school $= 15$

$\frac{1}{84}$,, $= 3$

$\frac{84}{84}$,, $= 3 \times 84$. Ans. 252.

6. A bill of £43 6s. 1½d. was paid with an equal number of pounds, shillings, pence, and half-pence. How many were there of each?

1 coin of each denomination amounts to £1 1s. 1½d.

$\therefore$ Number of coins $= \frac{£43\ 6s.\ 1\frac{1}{2}d.}{£1\ 1s.\ 1\frac{1}{2}d.} = 41$. Ans. 41.

ALGEBRA.

Third Year.

1. Find the factors of $x^2 + x - 182$, and show that—

$(y+z)^2 - x^2 + (z+x)^2 - y^2 + (x+y)^2 - z^2 = (x \times y \times z)^2$.

(*a*) $x^2 + x - 182 = (x + 14)(x - 13)$.

(*b*) $y^2 + 2yz + z^2 - x^2 + z^2 + 2xz + x^2 - y^2 + x^2 + 2xy + y^2 - z^2$

$= x^2 + y^2 + z^2 + 2xy + 2yz + 2xz$

$= (x + y + z)^2$.

2. Find the H.C.F. of $x^3 - 5ax^2 - 7a^2x + 35a^3 + x^3 - 5ax^2 - 4a^2x + 20a^3$, and the L.C.M. of $42(a^2b - ab^2)$ and $147(a^3 - b^3)$.

(*a*) $x^3 - 5ax^2 - 7a^2x + 35a^3$

$x^3 - 5ax^2 - 4a^2x + 20a^3$

$- 3a^2x + 15a^3$

$- 3a^2(x + 5a)$.

H.C.F. $= x + 5a$.

(*b*) $42(a^2b - ab^2) = 2.3.7(ab)(a - b)$

$147(a^3 - b^3) = 3.7.7(a - b)(a^2 + ab + b^2)$.

L.C.M. $= 2.3.7.7(ab)(a - b)(a^2 + ab + b^2)$.

3. Add $\frac{b}{b^2 - a^2}$ to $\frac{a}{(b-a)^2}$ and $\frac{x}{x - 4y}$ to $\frac{4xy}{(4y - x)^2}$.

$\frac{b}{b^2 - a^2} + \frac{a}{(b-a)^2}$

$= \frac{b^2 - ab + ab + a^2}{(b+a)(b-a)(b-a)}$

$= \frac{a^2 + b^2}{(b-a)^2(b+a)}$

$\frac{x}{x - 4y} + \frac{4xy}{(4y - x)^2}$

$= \frac{-x + 4xy}{(4y - x)^2}$

$= \frac{x(4y - 1)}{(4y - x)^2}$

4. What are the different steps in the process of solving a simple equation?

(*a*) Clear of fractions.

(*b*) Collect unknown quantities on one side and known on the other.

(*c*) Collect each side.

(*d*) Divide by the coefficient of the unknown.

(*a*) Solve $\frac{4x}{x+1} - \frac{x}{x-2} = 3$

$= 4x(x - 2) - x(x + 1) = 3(x + 1)(x - 2)$

$4x^2 - 8x - x^2 - x = 3x^2 - 3x - 6$

$6x = 6$

$x = 1$ Ans.

(*b*) In a division the majority was 140, which was $\frac{7}{13}$ of the whole number of voters; how many voted on each side.

Set x = minority,

then $x + 140$ = majority,

$x + x + 140$ = total number of votes.

Then $\frac{7}{13}(2x + 140) = 140$,

$2(2x + 140) = 140 \times 13$,

$4x + 280 = 1820$,

$4x = 1540$,

$x = 385$.

Ans. 385 and 525.

(To be continued.)

PRIZE BOOKS.

MESSRS. BLACKIE AND SONS' LIST.

The Tiger of Mysore. By G. A. Henty.

This is pre-eminently the first of Mr. Henty's works. It contains, in common with each of this year's 'Henty's,' a beautiful reproduction of the author's self with autograph, which will be prized highly by Henty lovers. The *dramatis personæ* are found in Dick Holland and the Surajah, a young Indian officer. Dick's father was originally the captain of a fine East Indiaman. He had sailed from England when Dick was nine years of age, since when they had heard nothing of his whereabouts. Supposition recorded that the ship had gone down with all hands, until the boatswain, three years later, turned up at the East Indian Company's Office to report himself, saying that Mr. Holland had been cast ashore on the territories of the Rajah of Coorg. With admirable pluck, Dick determines upon going in search of his father, and while in India he meets with the Surajah, who, it is decided, is to make his companion for a further research. Their adventures, as is usual, are many and exciting; Dick's ready wit and pluck always pulling them through. Eventually they find Mr. Holland in one of Tippoo's forts. The Tiger of Mysore is another name for Tippoo Saib. Three maps are given, and we cannot speak too highly in praise of this custom. It is by far the best way in which to plainly show how a campaign was conducted, the way in which forces were placed, and how towns were situated in respect to each other. These maps comprise quite a small education in themselves. Many of the details describing how prisoners were treated are culled from facts. Mr. Henty writes with all his old verve, and for instruction and entertainment it would be hard to excel him as he is here.

A Knight of the White Cross. By G. A. Henty.

The hero of this story is Gervaise Tresham. His father, Sir Thomas Tresham, was a staunch Lancastrian, and was one of the unfortunate gentlemen who were murdered by treachery outside Tewkesbury Church, where they had taken refuge after the battle of Tewkesbury. Sir Thomas had already bequeathed Gervaise, his only child, to the Order of St. John, or 'The White Cross,' and left directions that his son should be placed under charge of Sir Peter D'Aubusson in the Convent at Rhodes. Lady Tresham being in extremely delicate health, hastened to comply with this last wish of Sir Thomas, and quickly carried Gervaise off to her husband's old friend. She only survived this duty a few hours, so that the boy's whole life was soon engrossed in learning all that should befit him for a White Cross Knight. Stories of knight-errantry have a charm all their own, and this particular one is written with all the grace and finish of its accomplished author. The boy or girl who follows Gervaise through his varying fortunes will gain a taste for history and romance of the first order. A better or more beautiful gift book could not be chosen.

Through Russian Snows. A story of Napoleon's retreat from Moscow. By G. A. Henty.

A good share of life on the coast, romance, and chivalry is mixed up in this charming story. Two brothers are separated by a series of mishaps whilst only boys. They meet again, men, in the depths of Russian snows. History and absolute facts are so adroitly worked into Henty's books, that one cannot read them without gaining knowledge, or improving that which we already possess.

At War with Pontiac; or, The Totem of the Bear. A tale of Redcoat and Redskin. By Kirk Munroe.

A settlement, given to an English officer a century and a half ago in Western New York, must needs be taken and held at considerable risk, as this narrative proves. The invasion of the white man often provoked all the hatred of the redskin's savage nature. There are several capital character sketches in this story. Poor little Major Bullen, with his bath tub, is irresistibly funny. 'Ah-Mo,' the the chief's daughter, is an ideal girl of gentle birth, redskin though she be. The book is an excellent one, and will be read with avidity by both young and old.

For Life and Liberty. By Gordon Stables, M.D., R.N.

This is a tale of the American Civil War. Two English lads became enamoured of the cause, and managed to ship from Liverpool for the scene of action. There is plenty of incident in the story—war and battle by land and sea. This is relieved by sweet peaceful scenes of home life and love. The death-bed of Stonewall Jackson is touching and beautiful—a man of iron, but beloved alike by friends and foes. The introduction of the noble dog, Wolf, adds lustre to an already brilliant story. The book is altogether excellent, inside and out.

For the Sake of a Friend. By Margaret Parker.

A really good girls' story. It tells about a girl who had been brought up in absolute quiet, without one single companion of her own age. She is suddenly introduced into a girls' boarding school, and, of course, is quite at a loss how to treat her schoolfellows. After much suffering and many trials, she finally succeeds to a place of honour amongst her schoolfellows, simply by sticking to truth and right. A book of sound moral principles, and withal an attractive story.

A Musical Genius. By the Author of 'The Two Dorothys.'

In this story, 'Hugo,' a boy musician, is fortunate enough to attract the attention of a wealthy gentleman, who is somewhat of a 'music maniac'; he at once becomes the boy's patron, and undertakes to educate him for the profession. The story tells of sacrifice and hard work on Hugo's part, and teaches that there is no royal road to success. There are several pathetic and touching incidents in the story. A very suitable gift-book for either boys or girls.

Hallowe'en Ahoy. By Hugh St. Leger.

This is a right-down good sea story. It is full of good nature and true-hearted friendship. There is abundance of peril and danger in the book, but one remembers best the warm hearts of the sea-going folk.

Under the Black Eagle.

The story of an English boy resident in Russia. One day he carried a letter for a friend, and although perfectly innocent of the fact that it contained socialistic sentiments, he was arrested and sent to Siberia. He and his friend manage to escape, and after months of weary travelling are rescued by an English officer. The story is extremely interesting.

The Secret of the Australian Desert. By Ernest Favenc.

The last Australian explorer, Leichhardt, who with the whole of his party vanished in 1848, forms the basis of this story. The author has worked out a likely and eventful history of the expedition, put together from the scant facts already known. This is a real book of adventure.

THE OXFORD UNIVERSITY PRESS.

'The Thumb À Kempis.'

Is a dainty little work. Novelty of style seems, indeed, to be the one aim in all kinds of present-day literature. Everyone has read their Thomas à Kempis' 'Imitation of Christ,' and now here we have a thumb edition for the fob pocket. Also, 'The Thumb Christian Year'—every bit as dainty—containing 'Thoughts in verse for the Sundays and Holy-days.' Each of these miniature drawing-room editions is got up 'regardless,' and reflects infinite credit upon the taste and ingenuity of the publishers.

We have also pleasure in acknowledging 'OXFORD HELPS TO THE USE OF HYMNS ANCIENT AND MODERN,' which is practically a concordance to the hymn-book.

MESSRS. W. & R. CHAMBERS' LIST.

The Blue Balloon. By Reginald Horsley.

Many people have never heard of the Shenandoah Valley, but most people have heard of Stonewall Jackson, and he, be it known, was the commander who superintended the army of Shenandoah. Perhaps it would have been better did the author add to the title 'A Tale of Stonewall Jackson,' instead of 'A Tale of the Shenandoah Valley.' However, this is quibbling over detail. We have read the book, and would fain confess to our having derived much enjoyment therefrom. Ephraim Sykes is a typical backwoodsman. They nick-named him 'Old Grizzly.' He was lank and lean, cool in an emergency, witty on all occasions, and possessed of the true Yankee drawl. Ephraim 'fixes up' a balloon, which, according to his reckonings, he and his friend, Lucius Markham, are to go up in and watch the American War. They embark and are caught in a storm from which they escape only to find themselves taken prisoners by the Federals when they land. They are compelled to join the corps. Lucian escapes and carries a despatch to Stonewall Jackson, leaving Ephraim among the enemy; but he returns to help his friend. Eventually they meet again, and are brought back by circumstances to their own party. The story is a good one, and amusing.

The Wizard King. By David Ker. A well-bound and handsome book.

The Wizard King, Mr. Ker tells us, is the title first applied to the great Polish conqueror by the Khan of Crim-Tartary, which afterwards became universal among his Turkish enemies, who, as usual, ascribed to magic the victories which were really the fruit of skill, courage, and faith in God. Holland had just been overrun by the armies of France, and had only saved herself from utter ruin by breaking down her sea-dykes, and drowning a whole province at once. Spain was rotting piece-meal under a king as bigoted and brainless as herself. In England, Charles II.'s wretched misrule had already kindled the evergrowing indignation which was destined, fifteen years later, to drive forth the last king of the House of Stuart, never to return. France, sword in hand, was robbing and insulting all her neighbours. Turkey was arming for the conquest of all Western Europe. Russia, which only half a century before, had seemed crushed for ever beneath the heel of victorious Poland, had regained her independence, vanquished Poland in her turn, wrested from her the vast plain of the Ukraine, with all its warlike Cossacks, and thus opened a way for the mightier achievements that were yet to come; for there was then at play in the Kremlin at Moscow, a swarthy, black-eyed, sturdy child of eight, as yet known only as Prince Peter Alexeievitch, but one day to be called PETER THE GREAT! With such a ground as this to till, can it be doubted that the story is anything but an instructive, and, necessarily, entertaining one? The numerous notes given show that the author knows his subject well. The skein is a long one and full of life, and it has been unwound in a masterly manner.

Thomas Alva Edison: The Telegraph Boy who became a Great Inventor.

Mr. E. C. Kenyon has dealt with his subject in an excellent and masterly manner. He has shown us how determination, love of one's work, and perseverance go a long, long way towards raising a man from poverty to wealth. Edison is, in the very highest sense of the word, a genius, and coupled with this, he is a man with a marvellous physique; in short, he is a man of a century, and his inventions create an epoch in the history of the whole world. Messrs. Chambers' book is fascinating and cheap. Like most biographies, it will stimulate those who read it.

Hugh Melville's Quest. By F. M. Holmes.

Tales of the Armada can never tire one. Old and young can read this tale and enjoy it. The reasons are not far to seek; good round type, and simple language. A mother receives news that her husband has been slain by the Spaniards, and one of her sons put to the galleys. The other son, Master Hugh of the Hall, as he is called, determines upon going out to find his brother. He sets out, with another companion, and joins Drake, 'Franky Drake,' as they dub him. Hugh's 'quest' is, of course, for his brother, whom he finds in the end, worn and wan through prolonged suffering in the galleys. The attack at Cadiz, the skirmishes with King Philip and his fleet, the taking of galleys—all these are old tales, but they bear re-telling, and will for many years to come. There is a decided freshness about this book which is appetising. The illustrations by W. Boucher are worthy of mention.

MESSRS. S. W. PARTRIDGE AND CO.'S LIST.

Holiday Hours in Animal Land. By Uncle Harry.

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We are pleased to once more welcome the foregoing lovely coloured picture books from this firm. The pictures and colouring alike are more tasteful year by year, and will doubtless gladden the hearts of many young folks. Also two small volumes entitled respectively:—

Love's Golden Key. By Mary E. Lester.

Letty; or, The Father of the Fatherless. By H. Clement.

Both containing good and interesting stories.

REVIEWS.

Stories for the School-room. 'Dot,' for Infants. London: Blackie & Son, Limited.

A very small reading book for very small beginners. It contains a simple story, written in easy monosyllables made into short sentences such as a young child would readily understand, and the incidents are of the kind that would appeal to the interest of little readers. We recommend it to teachers of Infant Schools.

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THOMAS L. HUGHES, Esq., Froebel House, St. Andrew's Hill, London, E.C. (*Secretary.*)

PROSPECTUS.

THIS Company has been registered for the purpose of acquiring and carrying on the business of JOSEPH HUGHES, the eminent Educational Publisher. Of the above Ordinary Share Capital, nearly four-fifths is held by Mr. Hughes.

The Company now offers to the public the above **First Mortgage** Debentures, bearing Interest at the rate of 4½ per cent. per annum.

Each £5 Mortgage Debenture allotted is to be paid for in the following manner—viz., £2 on application; £3 on allotment.

The Debentures will be redeemable at the option of the Company in the year 1900, at a premium of 2½ per cent.

The Debentures will be secured by and form a first charge upon all the property of the Company, which consists of the Copyright of valuable published works, electro and stereo plates, moulds, illustrative blocks, stock-in-trade, fittings, goodwill, and the lease of Froebel House.

Among the Copyrights is the 'PRACTICAL TEACHER,' founded (1881) and edited by Mr. Hughes, and which may fairly claim to be the leading Educational Monthly Magazine in the world. It is acknowledged to have no rival in any language. It has had, and now has, with scarcely an exception, the liberal support of the foremost Educational Houses.

The following certificate has been received from Mr. A. M. Burghes, the well-known Accountant and leading English Copyright Valuer:—

1a, Paternoster Row, London, E.C.,
September 4th, 1895.

To **Messrs. Joseph Hughes & Co.**

Dear Sirs,

Having carefully examined the earning power of your business, I have much pleasure in saying that the net profits are equal to the payment of more than double the amount of interest you propose to pay on £25,000 Debenture Stock.

I have not herein included work in hand, and many manuscripts which are of much prospective value, being written by leading authorities.

I am, dear Sirs, your obedient Servant,

(Sd.) A. M. BURGHES.

As showing the character of the UNPUBLISHED MSS. alluded to in the closing sentence of Mr. Burghes' letter, the following selection may be mentioned:—

1.—**BIBLE LESSONS FOR INFANTS.** By Joseph R. Diggle, M.A., Member of the School Board for London, and for many years its Chairman.
2.—**KINDERGARTEN (PRINCIPLES AND PRACTICE OF).** By Miss Mackenzie, late Mistress, the Kindergarten Practising School, Stockwell Training College. When published, this will form the most important work on the subject in the English language, containing, as it will, many hundreds of original illustrations.
3.—**ADVANCED HYGIENE (Science and Art Department).** By Prof. Walker Overend, M.D., B.Sc., &c., &c.
HONOURS HYGIENE. By the same Author.
4.—**LAUNDRY WORK FOR TEACHERS (THEORY AND PRACTICE OF).** By Mrs. Lord, Senior Organiser and Superintendent for Laundry Work under the School Board for London. Profusely illustrated.
5.—**A FIRST SCHOOL COOKERY COURSE.** By Miss Tattersall, Senior Organiser and Superintendent of Cookery under the London School Board.
6.—**PUPIL TEACHERS' NEEDLEWORK.** By Miss Sophy Loch, Examiner in Needlework to the London School Board.
7.—**ADVANCED AGRICULTURE (Science and Art Department).** By A. T. Burgess, Medallist; Author of 'Elementary Agriculture.'
8.—**NATURAL HISTORY FOR INFANTS (Illustrated).** By Violet Wallace, daughter of Dr. Alfred Russell Wallace, F.R.S.
9.—**HISTORICAL BIOGRAPHIES.** By Prof. Green, M.A., Cambridge.
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11.—**ELEMENTARY LESSONS IN AGRICULTURAL ZOOLOGY.** By Prof. J. R. Green, Sc.D., and F. L. Green.

If no allotment is made the Deposit will be returned in full. If the amount allotted is less than that applied for, the balance of the Deposit will be applied towards the payment of the amount due on allotment.

Applications should be made on the accompanying form. (*See* page xxxii.)

The Avon Historical Readers, Books I., II., III., VI., and VII. London: Sir Isaac Pitman & Sons.

This new series of reading books on English history is certainly worthy of the attention of teachers. The matter of the first two books consists as usual, as indeed the Education Code requires, of simple stories relating to the history of our country. Here they are told with a simple directness and vigour which will make them very acceptable to school-boys. The famous old legends upon which historical research has cast grave doubts are included, but the warning is here and there given that they may not be true; yet they are pretty and interesting, and they represent what people have believed with regard to their early history. In Book II. the story of the discovery of the New World is vividly narrated, and this is followed by the Spanish Armada, the Pilgrim Fathers, and other stories on to Clive, Nelson, Wellington, and last, 'The Heroes of Peace.' Telling quotations and literary references are introduced, such as Longfellow's Miles Standish and John Alden in connection with the Pilgrim Fathers, and the well-known song 'The Admiral's Broom,' by Mr. Weatherley, forms one of the readings on the Commonwealth period. The type used in these early volumes is remarkably bold and distinct.

Book III. also consists of a series of stories down to the year 1845, but they are told with rather more historical detail, and are adapted to the capacities of third standard children. Coloured maps are introduced as well as others in black and white, but we do not admire the plan of printing these on the inside of the covers and on the fly-leaves.

Books VI. and VII. form a continuous history of England in two volumes, the dividing point being the date 1603. The matter is presented in a spirited style, and due attention is given to the 'life and ways of the people.' Political changes are carefully treated. Biographies of eminent persons are interpolated at suitable places. Above all, art and literature are not neglected, for example, one chapter is devoted to 'Utopia' and Sir T. More, and the last five chapters in Book VI. are on Elizabethan literature. Chapters on architecture are also given at intervals.

All the volumes are abundantly illustrated, and most of the pictures are suitable and well-produced. We ought especially to mention the many illustrations from drawings by Sir John Gilbert and by R. Caton Woodville, and the capital selection of views of famous castles, cathedrals, and other public buildings which illustrate the styles of architecture. These views, which are very numerous and occur throughout the series, should prove very instructive. We could spare the rather dreadful pictures of the death of Joan of Arc in Book I., and the murder of Edmund in Book III.; and some others by an artist named Branscombe err by their excess of conventional romanticism.

The books are very well printed, but we notice that small letters are uniformly, and so we conclude intentionally, employed in certain places where capitals are most often used. Thus we have Edward the fourth, Christ's college, lord Wolseley, king James, the mahdi's followers, and so on. The binding is neat and appears to be strong.

Altogether, we think the series a valuable addition to the increasing number of school reading books.

The Child's French Book. By F. Hahn. London: E. Marlborough & Co.

The preface to this book opens with a very sensible remark—'Foreign languages must be early taught to children, but they ought to be taught in play.' This is followed by another—'To begin to teach a child a language by rules and grammar is a perfect violation of the laws of nature.' With this also we heartily agree, but when the author goes on to claim that this book is based on these natural laws we are bound to differ. The natural way to teach a child a foreign language is to make his ear familiar by frequent repetition with the equivalents in that language for the simple expressions he has learnt and uses with intelligence in his own. In this book, after a few pages on the alphabet and the accents, some hundreds of French words are given, arranged only according to the sounds they illustrate, and including many which a young child would be likely neither to use nor to understand. Moreover, the French only is given. Next we have long lists of nouns with their meaning in English, and their pronunciation added. On page 32 very short sentences are introduced, and on page 64 easy reading lessons with interlinear translation. We do not say that an earnest careful teacher could not produce good results on this system, but we cannot admit the claim that it is founded on natural laws.

Another fault in the book is inaccurate printing. On one page we find these as English words—*neighes*, *cooes*, and on the next *screaches*, and *grashoper*. A little further on is *oulet* for *ourlet*, a hem. The fact that the book bears a foreign *imprimatur* may explain these errors, but they make it hardly a fit guide for young children beginning to learn a foreign tongue.

Hand and Eye Training. Part I., Practical Lessons on Paper-Folding; Part II., Brick-Laying and Parcel-Tying. By A. W. Bevis. London: Syers & Co.

These little books form very practical guides to teachers who may adopt the occupations of which they treat as complying with the requirement of Varied Occupations and advanced Kindergarten work in the lower standards of schools above the Infant Department. The instructions are very definite, and the work provided in each book seems amply sufficient for one standard for a year. If we may offer a criticism on the kind of work, it is that in both books the tendency seems to be to train in a technical rather than in an artistic direction, to develop cleverness rather than taste. At the same time, there is considerable variety in the exercises, and the author shows a thorough acquaintance with good methods of teaching, and is quite awake as to the need for various means of securing attention and carefulness if any good results are to be obtained.

The mechanical process of brick-laying is made very interesting, and the lessons in this subject are intended to be varied by the interspersion of lessons on parcel-tying with the use of different knots, and the explanation of a number of string tricks.

The plan of connecting the work as much as possible with drawing deserves hearty commendation. The works have been adopted in the schools of the Birmingham Board.

Old Testament History for Junior Classes. By the Rev. T. H. Stokoe, D.D. Part I.—From the Creation to the Settlement in Palestine. Oxford: At the Clarendon Press.

The work of which this is the first part promises to be a valuable text-book for the teaching of Scripture history in the lower forms of public schools and other places where the instruction must be of an elementary but not very childish nature.

Dr. Stokoe has selected thirty-three readings from the Pentateuch. Rather more than half of these are from the book of Genesis, and record leading events in the lives of the Patriarchs, and the rest are from the later books, and treat particularly of Moses and Joshua. Besides the readings, there are about the same number of abstracts, which give in a clear and simple style a connecting narrative of the periods of history intervening between the incidents recorded in the selections. Both the Bible readings and the historical abstracts are printed on the left-hand pages of the open book, and on the right is a series of explanatory and illustrative notes, which have been carefully compiled to elucidate the text. References to other passages in the Old and New Testaments are numerous, and recourse has been had to the best authorities on historical, traditional, and geographical matters relating to the text.

A melancholy interest attaches to the last paragraph in the preface, where the author expresses his thanks to Archdeacon Palmer, whose death is just announced, for his help in looking over the proof sheets, and making many valuable suggestions.

We heartily commend the volume to the notice of teachers.

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The Tutorial Series. The Peloponnesian War: A History of Greece, 431 to 404 B.C. Sparta and Thebes: A History of Greece, 404 to 362 B.C. By A. H. Allcroft, M.A. London: W. B. Clive.

These two volumes, dealing with important periods of Grecian History, keep up the credit of the University Correspondence Press, both as regards their appearance and their contents.

The facts of the history are presented in a concise form, with much fulness of detail and clearness of statement. The condensation of the matter does not, however, result in the work becoming dry and uninteresting. On the contrary, the briskness of the narrative, and the care taken to show the connection and interdependence of the events described, combine to make the book thoroughly readable. In a text-book prepared for real students this is no slight merit.

The first of the two volumes carries the history to the end of the Peloponnesian War in the fall of Athens, and closes with a brief sketch of the Greek authors during the period which is regarded as the Golden Age of Greek Literature. The second volume opens with a short paragraph which is open to misconstruction, if it is not, indeed, an actual misstatement. 'The fall of Athens, in 404 B.C., marks an era. In one sense it is the last notable event in the history of free Greece, and from this point dates the loss of Hellenic liberty and independence. With Athens' fall ends also the Golden Age of Greece, a Golden Age of fifty years only.. (480–431 B.C.).' But Athens did not fall till twenty-seven years after the latter date. This must be a slip on the part of our author, who is usually so careful and trustworthy. The later volume deals with the declining fortunes of Greece, when Sparta and Thebes in turn held supremacy. Chapter VIII. in the first volume is devoted to the expedition to Sicily, and Chapter VI. in the second volume to the subsequent affairs in that island.

We must not omit to notice the excellent chronological and analytical tables prefixed, and the capital series of test questions appended to each volume. These will be of much service to the student, and placed where they are they do not interrupt the course of the narrative.

The Cathedral Paragraph Psalter. Edited by the Rev. J. Troutbeck, D.D. London and New York: Novello, Ewer, & Co.

To the title of this book, on its title page, are subjoined the following words, which more definitely describe its scope and purpose:—'containing the Canticles, Psalms, and Proper Psalms, arranged in paragraphs, and pointed for chanting, together with a scheme of appropriate chants and brief notes on the Psalter.'

The arrangement in paragraphs is intended to group the verses for the purpose of adapting the chants to suit the subject, and suggestions are added as to the suitability of single, double, triple, or quadruple chants for the different portions. The pointing is based on that of the well-known Cathedral Psalter, also edited by Canon Troutbeck. Musical notes are placed over the final words of the initial bar in each verse to indicate the time divisions of that bar. The scheme of chants is very complete, and is likely to be very useful in guiding organists and choirmasters to a judicious choice of chants for all the psalms and canticles. The brief notes on the Psalter are descriptive of the purport and character of each psalm.

We can well believe the statement in the Preface, that the work 'is the outcome of many years of study, reflection, and experience.'

The publishers have done their part well in the production of the book.

Varied Occupations for the Standards. Course III., Cardboard Modelling. By William Nelson and Albert Sutcliffe. London: George Philip & Son.

We have had occasion to make favourable mention of preceding numbers of this series, from the excellence of which 'Cardboard Modelling' in no measure detracts. Excellence of illustration is admirably backed up by pithiness and brevity of direction, so that the veriest neophyte, after a careful study of the volume now on our table, would be in a position to introduce Cardboard work as a varied occupation. We have gone carefully through the book, for which we have nothing but praise.

Good Morning! Good Night! Morning and Evening Readings for Children. By the Author of 'Beneath the Banner.' London: Cassell & Co., Limited.

This collection of short readings will be welcome to many people who have the charge of children. Each of the readings is preceded by a Scripture text; and the first paragraphs are in most instances devoted to a brief explanation of its meaning and practical application. Then follows a story in illustration of the lesson to be enforced. The lessons are just such as need to be impressed upon children, being on courage, patriotism, love, obedience, and other similar subjects, and the stories are interesting, simple, and for the most part well chosen for their purpose. They are told in a way to attract attention, and the excellent motive of the author is everywhere conspicuous. At the same time we do not feel able to give unqualified approval to the book. There is rather more than seems desirable of the "preachy' style about the readings, and the phraseology is too largely of a theological cast. We are inclined to think the readings would be more appreciated by young children, and quite as likely to effect the good purpose the author has in view, if the stories were given with less of the narrowly religious talk which usually introduces them. But parents and others who read the stories to children can of course make such omissions and modifications for themselves.

Poésies de l'Enfance. Choisies par François Louis. London: E. Marlborough & Co.

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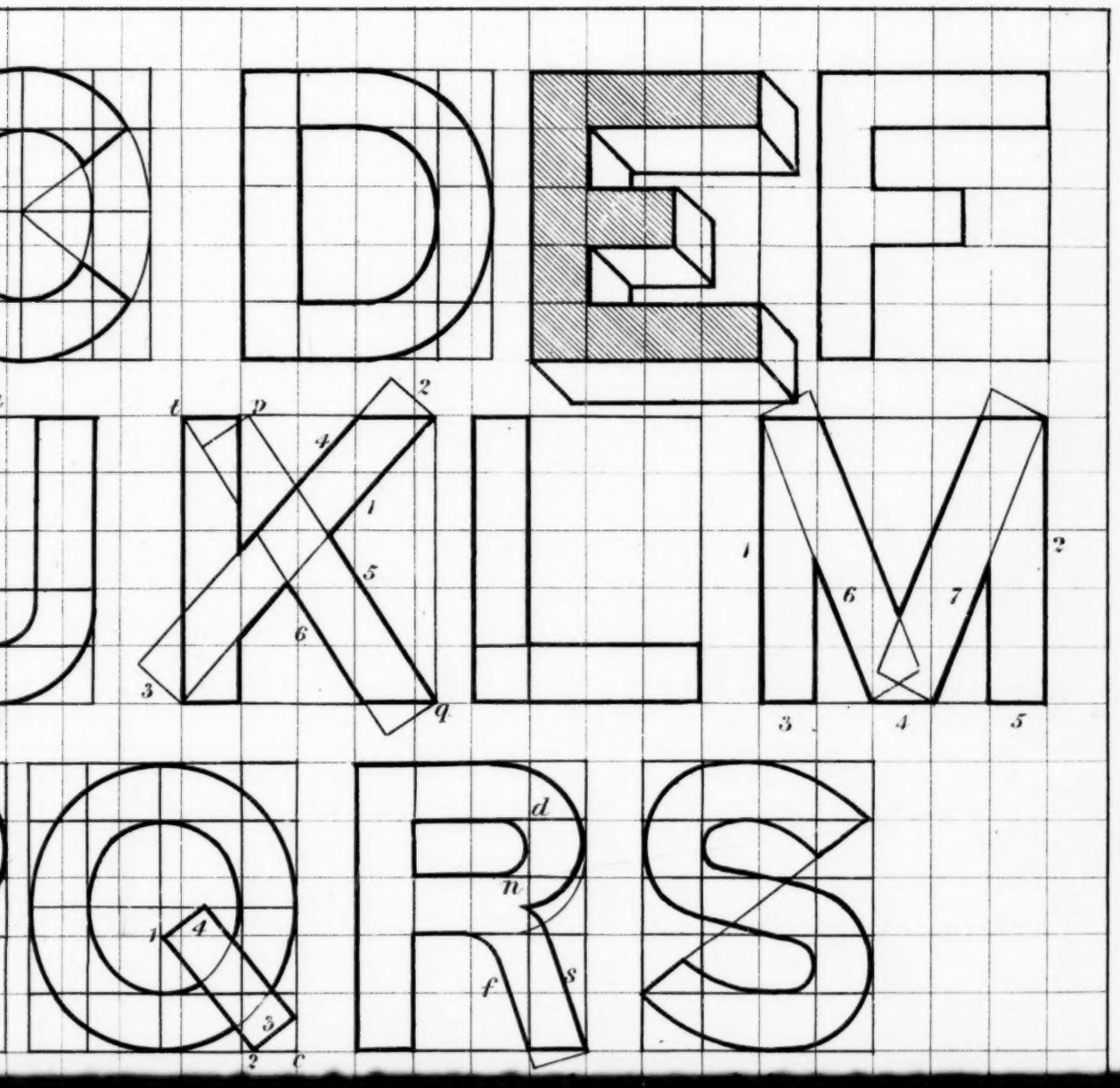

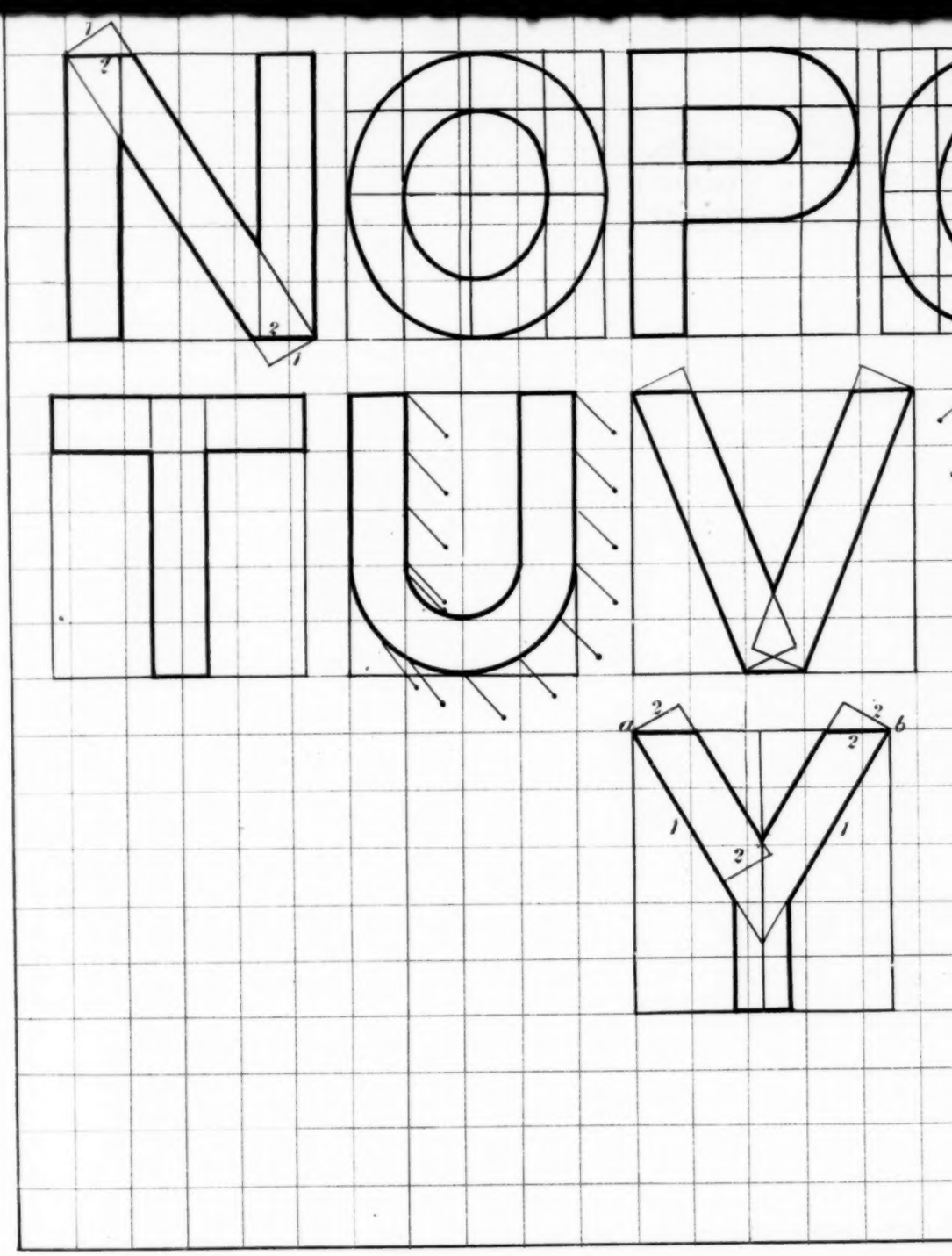

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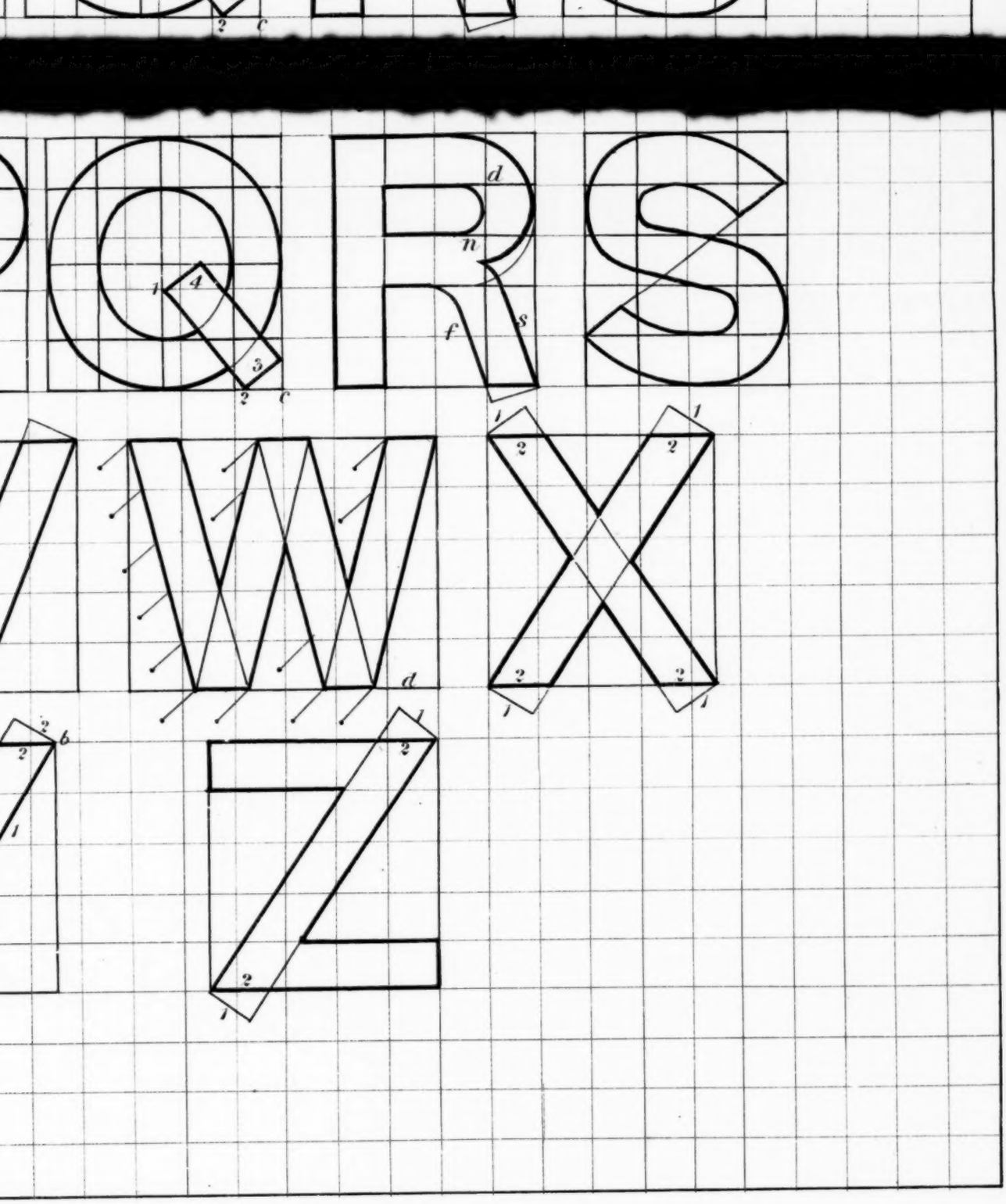

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